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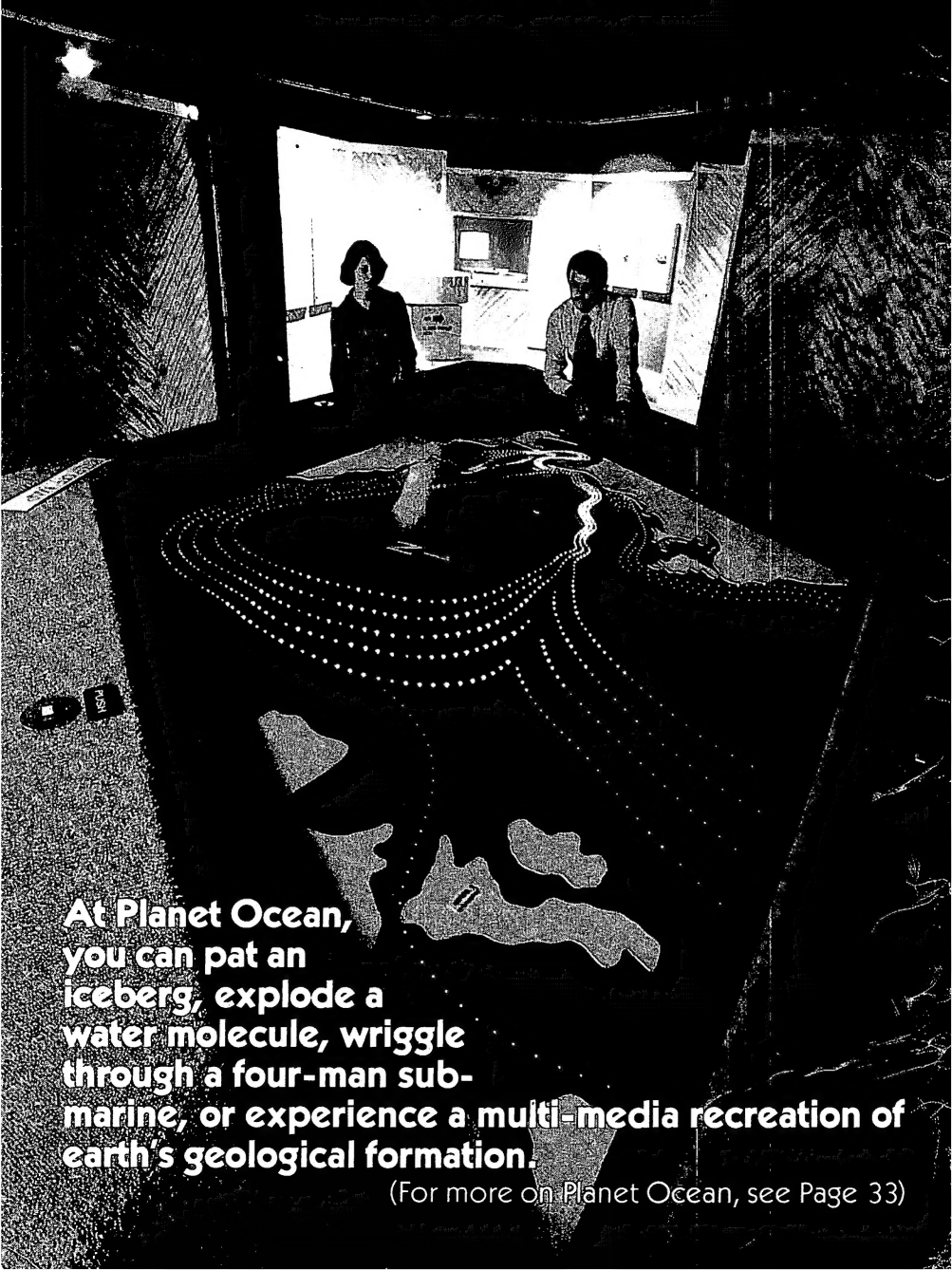
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(For more on Planet Ocean, see Page 33)

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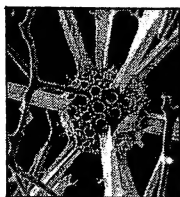
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Feedback

Time Warp

Regarding August's *Quick Quiz* ("If you take your watch . . . etc."). Dutifully I looked at MY watch and thought it probably would go the same wherever I take it, whether up a mountain or down a coal mine, except of course, under water where it would stop altogether.

However, when I peeped at the answer, I found you were referring to one of those old-fashioned things, with bits of springs and lots of cogs and jewels, which has to be wound every day.

Surely you know of LED quartz watches, don't you? Would my watch go faster or slower if I took it up a mountain (or down a coal mine)?

DONALD B. GOODHEW
London

A well-timed query, to which we reply: Quartz crystal watches are packed in air-tight containers, thereby rendering their mechanisms impervious to the atmosphere. In addition, the physical amplitude of a quartz crystal vibration is so small that the effects of atmospheric friction are negligible. Your timepiece will stay the same, regardless of height and depth.—Ed.

Radiation in the South

"The Ultimate Trip for Summer Nights" (*Sci/Di*, June '77) contains this reference:

"Thus we are actually nearer the sun in summer than in winter

with the result that seasonal extremes in temperature are more moderate than they would be if the situation were reversed."

If the statement refers to the Northern Hemisphere, it is incorrect as perihelion occurs in January, which is the U.S.A. winter. In a pamphlet describing the use of a vitamin and trace-element tablet, sold in South Africa for prevention and alleviation of sunburn, the following item appears:

"SOUTHERN SUMMERS ARE FIERCER: At perihelion (nearest position) in December/January the earth is approximately 91,500,000 miles from the sun and at aphelion (farthest position) approximately 94,500,000 miles away. The difference, although less than 4 percent of the sun's mean distance from the earth—due to the law of inverse squares—results in an increase in radiation of approximately 8 percent as compared to Northern summers in a similar latitude."

There is little doubt that increased radiation in the Southern Hemisphere is a reason why skin cancer is more prevalent among the white-skinned populations in South Africa and Australia. However, as the ocean areas in the Southern Hemisphere are greater than in the Northern Hemisphere, the climate, insofar as temperature is concerned, is tempered to a certain extent.

A. J. McLACHLAN,
F.C.I.S., A.C.W.A.
Director, Sylvachem, Ltd.
Pietermaritzburg, Natal,
SOUTH AFRICA.


Are You Causing a Tornado?

And you always thought of scientists as stolid, gray types who concerned themselves with

genes, quasars, quarks, enzymes and other such impenetrable stuffs.

If you would really understand your typical scientist, consider the debate lately gracing the pages of *Nature*, that normally staid and highly respected British science journal.

It started when four scientists in California reported a study that



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—Max Cortine, reporting in the Santa Cruz “Good Times” paper, about the WHOLEMIND Intuitive Research Program.

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Feedback

statistically linked driving on the right-hand side of the road with an increase in tornadoes in this country.

The four—J. D. Isaacs, J. W. Stork, D. B. Goldstein, and G. L. Wick—said driving on the right side produces air currents that, in the Northern Hemisphere, are conducive to tornado formation.

The scientists are affiliated with the Foundation for Ocean Research in San Diego. They began the study rather as a joke but, after obtaining statistics from the National Severe Storms Forecast Center in Kansas City, they noticed an actual relationship. So did some computers after they were fed the information.

The most important finding of the study, according to Dr. Stork, is that a significant lull in tornado activity occurs on Saturdays, when traffic is largely one-way out of cities. The Sunday flow is back toward the city, "completing the cyclical effect," so there is a resumption of tornado activity.

Keen, huh? Well, they *think* so and so do a lot of their buddies who got together in a "Tornado Forum" in a recent issue of *Nature*, where everybody—gosh, these guys are fun-loving—discussed the tornadoes-caused-by-Chryslers syndrome.

It's pretty weird. Grant L. Darlow of the University of Missouri's Department of Atmospheric Science blames the press, for tornadoes that is:

"... the small amount of property damage and infrequent personal injuries do not make newsworthy items for the large metropolitan dailies. These storm reports are frequently

covered only by local weeklies and the smaller out-state 'daily' papers. It is in these 'dailies' that the anomaly on Saturdays has its origins."

Media critics everywhere. Conspiracy types, too: D. K. Lilly of the National Center for Atmospheric Research testifies that tornadoes could "... conceivably be produced in the way the authors envisaged ... if all the vehicles in the U.S.A. drove in the same direction along highways close to the coastlines and borders."

Yes, but who would mind Nebraska if we were all on the coasts, joyriding?

Anyhow, I bring this up just to prove that science still has room for the occasional wacko who comes along, a la Sir George Sitwell.

As you certainly recall, Sir George, the father of Sir Osbert, was no mean scientist. Among his inventions were a revolver for shooting wasps and a musical toothbrush that played "Annie Laurie."

Sir George passed his days writing learned treatises with such titles as "The History of the Fork," "Leper's Squints," and "Introduction of the Peacock into Western Gardens."

BOB QUARTERONI
Petersburg, PA.

Notable Quotes

"The polyester bottle you drink from today could be the pants you wear tomorrow."

—Thomas F. Minter,
Goodyear executive
vice-president for R&D

FROZEN STIFF?

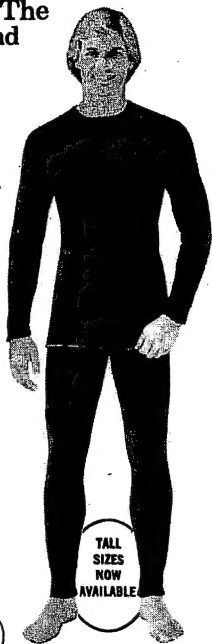
It's 10° outside . . . Even getting colder. So you bundle up in layers and layers of heavy clothes. First with long underwear . . . then bulky, restrictive thermalwear on top.

Oh, you were warm all right. Like in a Turkish bath. Because you began to perspire from all your activity. And perspiring in that mountain of clothes is like perspiring in a plastic bag! The perspiration is locked in. So there you are. Wet and miserable.

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"The balloons, 80 feet above us, had caught the first of the daily wind that rises with the Sahara sun. The balloons couldn't remain on the ground much longer; it was time to fly. Two burners exploded into flame..." It was

FIRE NEAR THE SUN

by Jon Gardey

THE ancient village slept; the dawn air was calm. The time had come for the flight. Quietly, like thieves making an escape, we began our preparations. First the nylon envelopes were spread on the dung-spattered sand of the central square of the oasis; then the wicker baskets, the burners, bottles of propane, ropes. All was arranged in silence, watched only by the single remaining eye of a withered old man huddled in his *djellebah* against the cool of the morning. His form broke the smooth outline of a dune, a silhouette against the fast-whitening sky to the east.

Bilma is about 400 miles east-northeast of Agadez, the regional capital of the desert portion of Niger. It lies near the exact center of the Sahara, an oasis of a thousand people isolated in space and time

from the rest of the world by the moonlike void of the largest desert on the planet. . . .

The sounds of our efforts drew several prisoners to the entrance of the former French Foreign Legion fort, the turrets and parapets of which bound the eastern side of the square. The fort is now a prison for the worst lawbreakers of the pauper African country of Niger, a landlocked land of sand and a few cattle. The prisoners are allowed free run of the oasis, for there is nowhere they can escape to. The men, their dark faces burnt blacker by the sun, their bodies clad in rags, edged closer to the nylon spread on the sand. They touched the massive envelopes incredulously.

The moment had come. The two pilots, one a Scotsman, the other English, were ready to inflate. With other members of the expedition holding open the mouths of the envelopes, they ignited the propane, and the blue flames roared into the nylon. The deafening sound shattered the peaceful morning of the village.

The warm light of the rising sun suddenly swept across the square, bringing to life colors of the clothes of the people and the purple; green,

Excerpted, with permission, from "Fire Near the Sun," in Mariah (Summer '77; Vol. II, No. 2). Copyright © 1977 by Mariah Publications Corp. Mr. Gardey, an Alaskan who now lives in England, is the author of Alaska: The Sophisticated Wilderness. He was educated as a meteorologist at the University of California.

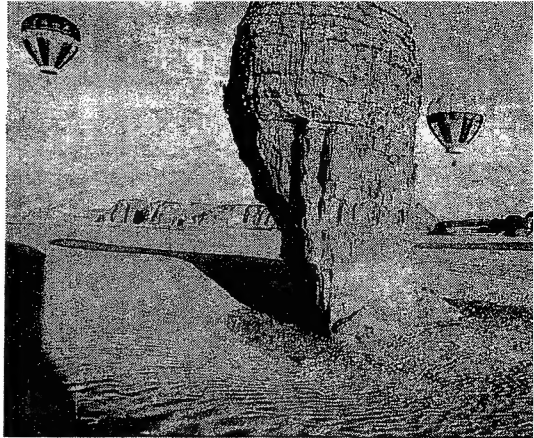
and yellow of the nylon. The crown ropes were released and the balloons stood erect, swaying gently above their baskets, floating in equilibrium and ready for flight. The burning stopped for a while, and the crowd, encouraged by the strange foreign balloonists, pressed to the edge of the baskets. Rings of black faces peered in at the incomprehensible collection of propane bottles, valves, and tubes. . . .

A teen-age boy appeared at the edge of the crowd, pushed forward by his friends. He was assisted into the basket. The burner roared, and the mass of people melted back. The balloon, *Golden Eagle*, rose like a bloom, tethered on a rope stem, until it was 50 feet in air. There, with the burner off, it oscillated gently over the square. The boy's eyes were just visible over the edge of the basket, darting around the crowd, searching for his friends. The balloon returned to the sand, and another volunteer appeared: the *Sous-Prefect*.

He was the local mayor, police

The December issue of Science Digest will announce the ten winners of the "Space Population" contest. ("How many objects will be in space on Oct. 4, 1977—the twentieth anniversary of the Sputnik I launch?")

A large number of entries were received before the Sept. 1 deadline, and—as promised—those readers who calculated most accurately the Oct. 4 census of objects in space as tallied by the North American Air Defense Command will receive one-year subscriptions to Science Digest (or extensions of their present subscriptions). Check the winners' circle next month!



Its base worn by blowing sand, a weird rock seems balloon-like, too.

chief, governor, representative of the national government in distant Niamey, and our gracious host. He would be given a real flight. In the eyes of his villagers he could show no fear, and did not. He was about 50, round, balding, and with an expression that treated any event, no matter how incredible, with official detachment. He had six wives and 18 children.

The *Sous-Prefect* climbed in beside the Scotsman with some difficulty. I joined the Englishman in the basket of *Daffodil*, named for its colors of green and yellow. Our two baskets were held to the ground by rows of expedition hands. The bulbous envelopes swayed menacingly over our heads, tugging at the baskets. Their tops, 80 feet above us, had caught the first of the daily wind that rises with the Saharan sun. The balloons couldn't remain on the ground much longer: it was time to fly.

Two burners exploded into flame. The crowd fled to the corners of the square, then reformed below us as we rose. At 100 feet I could see the entire village in its isolation. Dunes

FIRE NEAR THE SUN

swept around the horizon, row upon row, without end. I looked up into the opening of the balloon and saw what appeared to be a solid kaleidoscope of color, composed merely of fragile nylon and hot air. The balloon gave us temporary release from the earth, enabled us to become part of the wind. We were now in its grip and we began to move with it, toward the salt mines.

Below us the village sand streets were streaming with running people, fed by the rapidly emptying square. Beyond the oasis the streams formed one stream that trailed across the desert, led by the black globes of our running shadows. Then, suddenly, *Golden Eagle* began to sink; perhaps the *Sous-Perfect* had demanded descent. It settled out of the wind and drifted lazily near the ground. It is always a kind of death. . . .

Daffodil sailed on. Ahead of us were the dunes that rose in parallel lines beyond the colored pools of the salt mines. We climbed with roaring burner to a thousand feet, leaving behind the crowd that had clustered around the *Golden Eagle*. *Daffodil's* flight would be the last one of the expedition, a flight with no purpose other than the experience of an act unique and pleasurable.

The edge of *Daffodil's* basket came to my waist. Movement was free, with vision unimpeded in all directions. There was no sound of wind. Below now were the salt pools, and among them a caravan of camels was being loaded with the blocks of salt gathered last fall. The low morning sun projected the shadows of the camels onto the sand so they looked like a child's game of cutouts, ready to be played.

Beyond the red and orange of the salt pools lay the sand sea. The Englishman stopped burning, and *Daffodil* cooled and sank toward the yellow dunes. He burned again at

A balloon is the only way known in which man can embed himself in the mantle of life that blankets the earth. A hang glider soars in beauty and grace, but it cuts the air, is never one with its medium. A balloon is like a leaf on a stream, buffeted and swirled in every eddy, uncontrollable except in altitude: a willing victim of the movement of invisible forces. There is no sound except the occasional burn. In temperate climes birds are heard, sounds of mountain streams, the rush of wind in trees, people talking on the ground.
—Gardey.

100 feet and we moved along in a light wind flow, our shadow clinging to the sides of each dune in turn. Dunes are final solutions to mathematical equations: perfect examples of applied calculus, their curves functions of wind speed and sand grain size, their leeward slopes precisely at angles of repose. The envelope over us supported our weight in answer to other equations, of which our flight was the solution.

The sun had warmed the sand into thermals that could now help support us for a time. The burner was silent. We became one with our environment, a bubble of air within air, floating, suspended. Humans and their works were left behind. We were among the endless dunes, uniform sands, shifting with the wind that guided us. They stretched for hundreds of miles. ■

Pressure differential lifts the huge envelope exactly like an air bubble rising to the surface in a lake... You can control vertical direction and velocity, but horizontal travel is

TOTALLY AT THE WHIM OF THE ELEMENTS

by Will Hayes

THE THEORY of balloon flight is directly related to the concept of using an envelope to trap gas which is lighter than the surrounding air. The principle dates back 2500 years to Archimedes.

As balloon pilots know, the atmosphere is heavier, or more dense, at sea level than at higher altitudes. An increase in altitude to 18,000 feet, for example, results in a corresponding decrease in atmospheric pressure of about 50 percent. Essentially, there is a pressure continuum—called a *pressure gradient*—starting at sea level and dropping in density as altitude increases.

A hot air balloon acts as a “pressure gradient detector.” There is more pressure at the lower part of the envelope than at the top, so the balloon tends to rise. It would seem the pressure differential between the

top and the lower portion of the balloon would be insignificant. The difference, however, is substantial in a balloon 70 feet in height. The balloon envelope acts exactly like an air bubble rising to the surface from the bottom of a lakebed.

Both gas and hot air balloons are similar in operational theory. The gas version consists of a closed envelope containing gas—usually helium or hydrogen—that is “lighter” than the atmosphere. In contrast, the hot air balloon envelope is open and it contains warmed air which is “lighter” than the ambient atmosphere. The bottom of the envelope is left open to permit the introduction of more warm air from the burner each time the balloon loses lift from air cooling in the envelope. . . .

Hot air balloons are more maneuverable, because relatively rapid changes in lift can be made without affecting the flight's duration. Hot air balloons carry a fuel—usually propane—which heats a burner to quickly provide additional lift. The balloon can quickly lose altitude merely by venting off some of the hot air from within the bag.

Various conditions effect the available lift of a hot air balloon. As noted, the primary lifting force in balloon flight results from a density differential between ambient gas and gas within the envelope. Thus, hot

This chapter, “Basics of Balloon Flight,” is excerpted with permission from The Complete Ballooning Book, by Will Hayes, an aeronaut. Other chapters include: History of Ballooning, Getting Aloft, the Fuel and Burner Systems, Balloon Maintenance, Safety, Getting Started, and FAA Regulations. The Complete Ballooning Book is copyright © 1977 by World Publications, and is available from the publisher, P.O. Box 366, Mountain View, CA., 94042 (\$8.95).

BALLOONING

air balloons require less temperature to fly in cold air than in warm. Humidity also influences available lift.

Lift also is lost with increasing altitude. As the atmosphere thins out, it becomes more difficult to maintain a density differential between the inside and outside air. This is particularly noticeable if an ascent is to be made to a high altitude, because burner efficiency decreases by approximately four percent per 1000 feet over the Mean Sea Level. Cold fuel tanks also reduce fuel pressure and burner efficiency as ambient air temperature nears 40° F.

The amount of lift developed is more than a simple theoretical consideration. In addition to the above factors, lift is effected by the weight of the balloon plus its passengers. Since fuel consumption is closely related to these considerations and flight conditions, a flight can be shortened by 25 or 30 percent of its normal duration when these combined factors come into play.

One final factor influences the theory of balloon flight. Since an aerostat travels with an air mass, the horizontal direction and velocity of each flight will depend entirely on the wind. Vertical direction and velocity can be controlled, but horizontal travel is totally at the whim of the elements.

BALLOON FLIGHT BASICS

The reasons hot air balloons have virtually replaced gas balloons in the United States are two-fold. First, hydrogen—is extremely explosive and is little used for manned balloon flights in this country. And helium—also a good lifting gas—is so expensive that one flight would cost several thousand dollars.

Hot air balloon flights usually take place shortly after sunrise or shortly before sunset because air movement is usually at a minimum during these hours. Mornings are usually preferred because the air is cooler and the balloon has more lift. As the day progresses and the earth is warmed by the sun, uneven heating of the land surface causes wind to rise. Coupled with thermals and other vertical currents, this results in very poor flying conditions. It is sometimes possible to fly in the late afternoon after the wind has died down, but such flights always carry with them the possible hazard of running out of daylight.

An open launch site usually is chosen—especially on the downwind side—so that nothing will be contacted by the balloon on take off. It is also wise to choose a place which is large, fairly flat, and with-

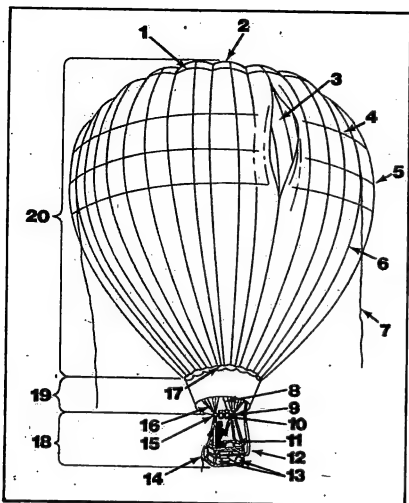
In 1963 there were only six hot-air balloons in the U.S. . . . Today there are nearly 1000. Some 3000 balloon pilots are licensed by the FAA and perhaps twice as many friends and relatives serve as non-licensed crew members.

—Time Magazine.

out sharp objects which might tear the balloon or impede the inflation.

Once a suitable launch site is found, the balloon is laid out and spread with (in some models) the maneuvering vent down, so air pumped into the balloon cannot escape through the vent. The basket is laid on its side, and crew members are stationed at the mouth of the balloon to hold it open. Of several methods for putting air into the balloon, the most popular is motor-driven fan.

The fuel and heat system should



(1) Rip panel top (or deflation port); (2) crown, or apex; (3) maneuvering vent (manually dumps hot air for descending); (4) load tapes (horizontal); (5) equator; (6) load tapes (vertical); (7) ground handling ropes; (8) maneuvering vent rope; (9) fuel regulator; (10) burners; (11) instrument panel; (12) rip panel cord; (13) propane tanks; (14) tether rope; (15) tie blocks; (16) load cables; (17) throat, or mouth; (18) gondola, or basket; (19) skirt; (20) envelope.

be fully checked prior to hooking up the envelope cables. This should include a "sniff test" and a test firing of the burners. As soon as the balloon has been puffed with cold air, the burner is activated and the blast valve cracked open. The resulting flame is much like a blast furnace. While heat is being shot into the balloon, members of the ground crew are stationed around the bag to hold the mouth open so it will not get in the way of the flame. As the balloon fills with hot air, they will let it slowly rise.

If the flame contacts the fabric, it will immediately melt a hole. seldom does this hole abort a flight, but such burn damage is expensive and troublesome to repair.

The propane fuel used in the burner is not as unpredictable as it might first appear. Remember that it must escape from the tank, mix with air, and contact flame before it is volatile. In the event of a leak, usually only a local flame results. Rarely does it suddenly explode out of control. One possible fire danger does exist on very cold mornings, however. Tank pressure can become a problem and propane will not necessarily vaporize as it comes out of the pilot. Under such a circumstance, it occasionally will drip and ignite on the floor of the basket.

As the balloon comes to an upright position, the man on the blast valve moves back into the basket to keep the balloon from taking off. The other members of the crew hold the basket in place.

As the burner blasts and the balloon starts to gain lift, the pilot will constantly monitor the temperature. Based on his prior knowledge and experience, he will have a good idea how much heat is required to cause the balloon to lift off. He will consider air and envelope temperature, humidity, weight of balloon and passengers, take-off altitude, and wind conditions.

When the temperature rises to that point where he would expect it to lift the balloon, the pilot will give the command "hands off." In ballooning language, this means to very carefully let go of the basket to determine buoyancy, but to stand ready to grab it again. This enables the pilot to determine how light his balloon is, and he may do this several times during his preparation for take-off.

Under ideal conditions, the basic idea is to take off slowly. In order to clear high tension wires, buildings, or other obstructions, how-

BALLOONING

ever, it may be necessary to get the balloon fairly hot and accelerate the ascent. But only through the experience gained from many takeoffs can a pilot learn how much lift is needed. Even under less than ideal conditions, beginning an ascent with excess lift should be avoided, because it puts severe horizontal stress on the envelope.

After the pilot takes off, it usually is his intention to ascend to an altitude and stabilize. He rises to a certain point and establishes equilibrium at that altitude. After stabilizing, he again uses the blast valve to heat up the balloon and start another ascent. This is called "stair-stepping," and it is the preferred method of both ascending and descending in perfect control.

When the blast valve is opened in a balloon, the response is markedly different from the response of a car or airplane when the throttle is advanced. There is a delay of 15-30 seconds before the balloon shows any indication of responding to the additional heat. The heat is supplied 50-60 feet below the apex of the balloon, and it requires time to rise inside the envelope.

It is difficult to overemphasize the variances that will be experienced in balloon handling characteristics as a result of factors such as ambient temperature, envelope temperature, humidity, weight, and altitude.

These factors are changing constantly during the course of a flight, and each change results in a handling variance. When the balloon goes up, an increase in altitude tends to give it decreasing lifting capacity. As the day wears on, the surface air will become warmer and less dense. The weight of the balloon will decrease constantly as propane gas is

Balloons are back. The question is, why?

Maybe it's because they're so colorful, or that they're (at times) quiet, or that they're such an anachronism. Maybe it's because they tend to bring forth the best qualities of mankind: sharing, laughter, cooperation, joy, inventiveness, peace. Perhaps it's the hours when the balloonist is alone aloft and feels the mystique of being one with God.

—Will Hayes

used during the flight. These changing factors are compensated for by a certain "feel" the pilot develops as he gains experience.

An experienced balloonist can bring his balloon down to a soft landing—lightly touching the earth, skipping across the surface if wafted by a light breeze. The ability to make a spot landing efficiently can be more important to both life and equipment. When it is necessary to land in a limited area, it is better to have a rapid, bone-jarring landing on the correct spot than a soft landing in the lion cage at a zoo.

Most balloonists prefer to fly at less than 400 feet, because at low altitudes they can best observe activity below. Much low flying is done during pilot training, as this is the most important skill a balloonist can possess. It is a challenge to fly for several miles with the basket never higher than 5 to 10 feet. ■

Additional information is available from the Balloon Federation of America, 806 15th Street N.W., Washington, D.C., 20005. Ballooning clubs have been organized in several states, and the FAA approves various schools instructing in ballooning.

As a case in point, consider first the dilemma of parents who discovered that their 16-year-old son had been on drugs for a year only when he was rushed from his school to a hospital, suffering from a "bad trip." The weeks following were a nightmare for the parents, not knowing how seriously the drug might have affected his brain.

"But now I'm sure we're past the crisis. I visited him in the hospital this afternoon—and for the first time I got him to *laugh*."

Studies show that laughter—the kind we associate with good humor, that is—can be an indication of mental and physical well-being. Research on the subject is relatively new, and in some cases bizarre. One day some years back, for example, a physician in London escorted a 13-year-old polio patient to a musical comedy to test an unusual program of therapy. An iron lung had been doing most of the boy's breathing for a year, and the theatrical spree was an experiment to see whether some outrageous antics on stage could help the youngster "laugh his way back" to breathing again normally.

lung during the performance. Soon after the curtain went up, he could not refrain from reacting to the comic acting of Tommy Steele. He laughed uproariously. Each time he did so, his nurse turned off the lung. Although the boy did not suspect what was happening, the laughter started his chest muscles working



again and for 20 minutes he breathed completely on his own. Later, at another comedy, the experiment resulted in 40 minutes of independent breathing, enough to prompt the doctor to report, "It's the start on the road back to normal breathing for him." ➡

LAUGHTER & HEALTH

Scientists studying the effects of laughter on people have reported a measurable effect, not just on the lungs, but on other important organs. Laughter, reported one study, "reduces health-sapping tensions and relaxes the tissues as well as exercising the most vital organs . . . Laughter, even when forced, results in a beneficial effect on us, both mentally and physically."

As one medical wag could not refrain from quipping, "He who laughs, lasts."

Laughter is a function almost entirely unique to humans, who are certainly the only animals capable of devising jokes and laughing at them. Anthropologists have established physiological counterparts in other animals, however. Primate laughter, for example, has been documented in chimpanzees by anthropologist Jane Goodall and apes are said to use laughter to signal playfulness.

In humans, laughter—when openly and heartily indulged—serves physiological and psychological needs. It does all these things:

- ☺ 1. Benefits the lungs
- ☺ 2. Clears the respiratory system
- ☺ 3. Provides a healthful emotional outlet
- ☺ 4. Provides an opportunity to discharge superfluous energy
- ☺ 5. Combats boredom
- ☺ 6. Alleviates "social constipation"
- ☺ 7. Helps to combat shyness, tension, and worry
- ☺ 8. Enables mankind to beguile the present in the same way that time can dim past tragedies or hope can brighten the future.

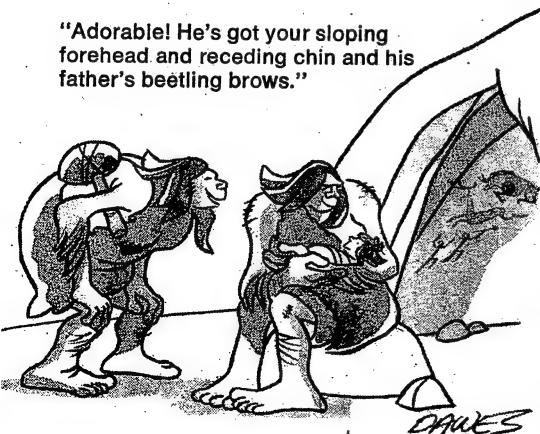
A psychologist, Dr. Herman Ryber, pointed out at a physicians' seminar, "Laughter and the awareness of humor become doubly important when individuals are in abnormal, non-humorous, situations.

"Unit commanders during World War II, for instance, felt that the situation was under control—despite mud, weariness, death, and danger—when the G.I.s under their command could still find something to laugh about."

In a parallel situation, Dr. Rose L. Coser, a professor at the Health Sciences Center of the State University of New York at Stony Brook, found laughter a safety valve for hospitalized patients away from their familiar, friendly environment and facing an unknown future with apprehension. Under these conditions, says Dr. Coser, laughter performs a vital social function, providing not only an outlet for discontent, but opening up communication with other patients.

Fortunately, laughter does not have to be triggered by clever jokes or professional wit. Dr. Coser de-

"Adorable! He's got your sloping forehead and receding chin and his father's beetling brows."



scribes a typical patient who admitted, "I was very apprehensive. I was frightened to death. I did not know what to expect." The mood changed when the patient, discussing food with her hospital roommates, declared, "Boy, were those hamburgers *tough*. If I'd thrown mine against the wall, it would have bounced right back over to your bed."

As Dr. Coser explains, this type of jocular gripe might get no reaction from another group at all—particularly if there is no common experience to share, or if the listeners are really angry or hostile. "People who are in despair," she explains, "or people who feel very strongly about something, do not have what is usually called a 'sense of humor.' Nothing is funny to a person whose strong feelings do not permit the toleration of ambiguities." When laughter is possible in this type of setting, it helps patients to regain their identity through collective triumph over their weakness and at the same time to release grudges in substituted complaints.

Situations that provoke laughter, and the various forms laughter takes, are psychologically interesting because they relate directly to circumstances, often depending for their effectiveness on the common experience of the listeners. We all recognize, of course, a kind of "soundless laughter," the inner enjoyment you may feel when you are alone, reading an amusing book. "It can bubble to the surface in a restrained fashion when in daydreams we conjure up or relive amusing incidents," explains Antony Chapman and Hugh Foot, authors of the book, *Humor and Laughter*, "and occasionally a specially talented author can draw us into a story so that

we are witnessing funny events firsthand."

But the enjoyment of humor is heightened and changed when another person is nearby and the reader, though not communicating what he is reading, chuckles audibly in a subconscious desire to share his delight. Another stage is when the reader cannot refrain from quoting the humorous passages aloud, and in turn is rewarded by laughter from the other person. In this case, the laughter is what one psychologist refers to as a "social phenomenon," the mutual sharing of an experience.

Will This Story Make You Laugh?

Shortly after the President of the United States made a telecast on the national economy and how much it cost for the basics of living each week, his telephone at the White House rang. Picking up the receiver, he heard a thin voice at the other end of the line.

"Mr. President, I don't want to sound impertinent, but you were way off base in the statement you made about the cost of food needed for a young couple."

"Oh, in what way?" asked the President.

"Your figures were much too high. Out here we live on a food budget of 89 cents a week."

"Eighty-nine cents a week!" exclaimed the President. "Would you mind repeating that a little louder, please, so I can be sure that I heard you correctly?"

"I can't talk any louder," squeaked the voice. "I'm a goldfish."

To compare your reaction with that of 50 other "normal and mentally healthy people of various ages" who also read the joke, see the boxscore on page 20.

LAUGHTER & HEALTH

Laughter can be a telling indication of the state of a person's mental health and personality, as well. Not uncommon is this form, "an affected and constrained laughter of insanity," as distinguished from the normal, healthy type of laughter referred to here. The Yale School of Medicine, after completing a research study, reported that a "mirth-response" test could be used to judge quite accurately whether a person was suffering from maladjustment or an outright mental disturbance. Dr. Jacob Levine, clinical professor of psychology, believes that "the ability to laugh is a measure of man's adjustment to his environment," whereas the inability to respond positively to situations that would make normal people laugh indicates trouble.

This does not, of course, mean that there's something wrong with

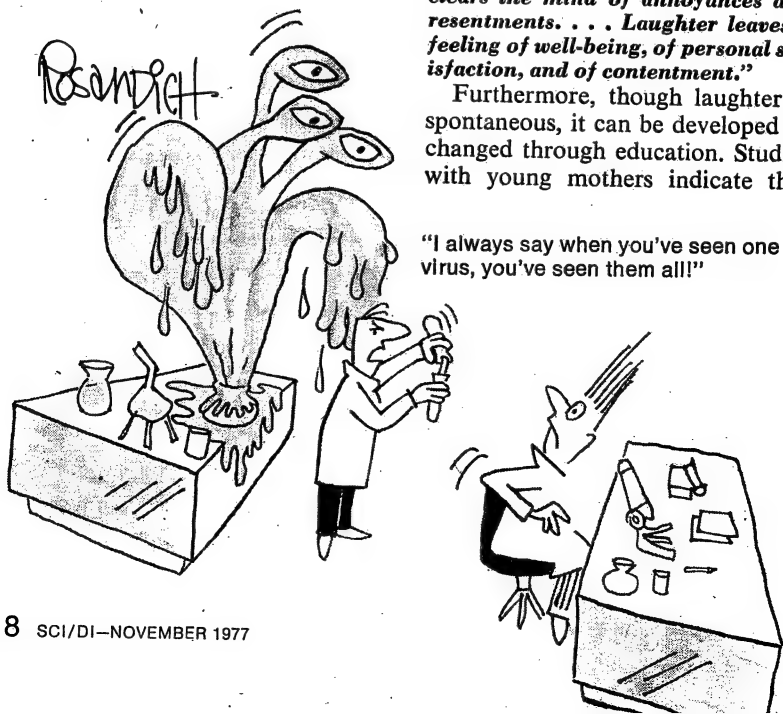
you just because you find no humor in a certain joke, or type of joke. It is the *cumulative* reaction—or lack of reaction—to a number of jokes, cartoons, or humorous situations that provides the clue.

People who enjoy the humor columns of magazines and newspapers, or who find relaxation in cartoons and comic strips generally are found to be in sound mental health. Those who avoid humor, whether cartoons, jokes or any other form, may be mentally healthy but possessed with a fear of losing their dignity or self-control. And the ones who do see and read humor but react with horror or disgust may be suffering deep-rooted anxieties.

A characteristic medical outlook on laughter is a statement by a psychologist with considerable experience:

"Laughter is good for both body and mind. It eliminates nervous tensions which upset body functions and it clears the mind of annoyances and resentments. . . . Laughter leaves a feeling of well-being, of personal satisfaction, and of contentment."

Furthermore, though laughter is spontaneous, it can be developed or changed through education. Studies with young mothers indicate that



The Positive Power of Laughing

In the *New England Journal of Medicine* and, later, in *The Saturday Review*, Norman Cousins has recounted for the first time details of a gallant battle he waged in 1964 against "a crippling disease that doctors believed to be irreversible."

He was believed to be suffering, he reported, from "a serious collagen illness—a disease of the connective tissue . . . In a sense, I was coming unstuck . . . One of the specialists (said) I had one chance in 500 . . . he had not personally witnessed a recovery from this comprehensive condition."

Mr. Cousins, conceding that "all this gave me a great deal to think about," determined to be more

than a "passive observer."

"Is it possible," he asked, "that love, hope, faith, laughter, confidence, and the will to live have therapeutic value?" With his physician, he outlined for himself a regimen, including massive doses of Vitamin C—and laughter.

Ultimately, his self-analysis proved wholly effective, and he returned to health and his extraordinary pursuits as editor, writer, lecturer and numerous other activities. Cautioning still against "creating false hopes in other persons similarly afflicted," he believes that the key is "the chemistry of the will to live." As to the unique role of laughter in his recovery in the face of the "almost hopeless" diagnosis, he has given *Science Digest* permission to quote the accompanying paragraphs.

"My doctor and I developed a program calling for the full exercise of the affirmative emotions as a factor in enhancing body chemistry. It was easy enough to hope and love and have faith, but what about laughter? Nothing is less funny than being flat on your back with all the bones in your spine and joints hurting. A systematic program was indicated. A good place to begin, I thought, was with amusing movies. Allen Funt, producer of the spoofing television program *Candid Camera*, sent films of some of his CC classics, along with a motion-picture projector. The nurse was instructed in its use.

"It worked. I made the joyous discovery that ten minutes of genuine belly laughter had an anesthetic effect and would give me at least two hours of pain-free sleep. When the pain-killing effect of the laughter wore off, we would switch on the motion-picture projector again, and, not infrequently, it would lead to another pain-free sleep interval. Sometimes, the nurse read to me out of a trove of

humor books. Especially useful were E. B. and Katherine White's *Subtreasury of American Humor* and Max Eastman's *The Enjoyment of Laughter*.

"How scientific was it to believe that laughter—as well as the positive emotions in general—was affecting my body chemistry for the better? If laughter did in fact have a salutary effect on the body's chemistry, it seemed at least theoretically likely that it would enhance the system's ability to fight the inflammation. So we took sedimentation-rate readings just before as well as several hours after the laughter episodes. Each time, there was a drop of at least five points. The drop by itself was not substantial, but it held and was cumulative. I was greatly elated by the discovery that there is a physiologic basis for the ancient theory that laughter is good medicine."

—Excerpted, with permission, from "Anatomy of an Illness" published in *The Saturday Review*, May 28, 1977.

LAUGHTER & HEALTH

babies laugh and cry with almost equal ease—and that they can be taught to laugh instead of cry on many occasions.

Dr. Charles R. Gruner, a University of Georgia professor who has been studying laughter and its causes for 20 years, concedes he still does not have all the answers.

The educational process has strong bearing on the subject, says Dr. Gruner, author of a new book, *Understanding Laughter*. "As children grow and develop, becoming more civilized, the range of things they laugh at grows. They originally laugh at physical successes . . . They are quick to laugh at cripples or other unfortunates. Later, as they develop verbally and socially, they delight in riddles, then punning riddles, and, much later, in the more subtle verbal jests."

Research also has underscored what we already have been aware of: that laughter is an important ingredient in presenting a favorable appearance. Children who laugh easily and often are more likely to be referred to by their elders as "beautiful" or "handsome" or "at-

Boxscore

Did the story on Page 17 make you laugh loudly? A little? Not at all? Or were you perhaps embarrassed? Whatever your reaction, don't worry:

Out of the 50 persons who read this joke, only 17 laughed aloud. Six "snickered rather self-consciously." Twenty-one showed no more reaction than if they had read a weather report. Two said Presidential jokes are disrespectful. Three said they had read such a joke many years ago. And one asked if it was supposed to impart some kind of message.

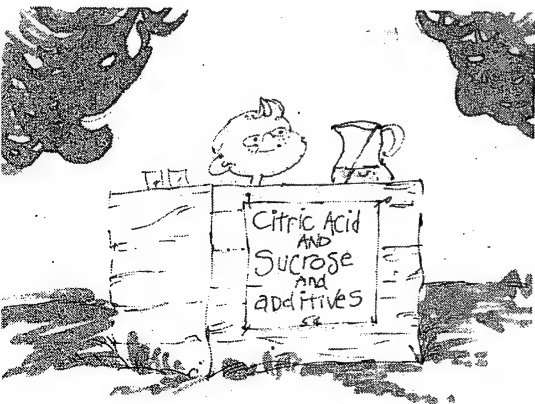
Humor is, indeed, unpredictable and personal . . .

tractive" than those who are sober of face and mien. This concept carries over into adult life.

It has been documented that laughter, along with a well-rounded sense of humor, is one of the surest signs of intelligence. The sharper a person's intellect, the more likely that laughter will come readily, all other factors being equal. Yet humor will always be—as in the case of the arts—a selective matter. If you split a gut at just about every joke you hear, it could mean that you need help, rather than praise as a great wit.

Humor is unpredictable, and each person has to find his own medium and his own level. The important thing, as in taking exercise, is to determine what best suits your own nature. But for all of us, no matter what the exact stimulus, laughter is a vital tonic—the best medicine anyone could want. ■

Adapted, with permission, from a forthcoming book, The World of Humor.



The ROBOTS Are HERE!

At about the same stage today as electronic calculators a decade ago, they may be as common

by Walter B.
Hendrickson, Jr.

Like space travel, robots no longer are science fiction. They already are here in all but their most advanced forms. Some even look like human beings.

We see them or their forerunners almost every day. These forerunners are the door-openers and other automatic devices. Photos of the Viking landers on Mars actually are photos of a robot doing remote scientific experiments for its human masters back on earth.

In the play *RUR*, the manlike in English some two generations ago by the Czech author Karel Capek in his play *RUR* (Rossum's Universal Robots), which was performed in the United States and Great Britain. Capek coined the term "robot" from the Czech word "robata" which means servitude or forced labor.

In the play *RUR*, the manlike robots revolted against this forced labor and took over the world. Since then the robots of science fiction have been tamed by Isaac Asimov, who made them always obey his

Three Laws of Robotics:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except when such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

Since then, practically all science-fiction writers have made their robots follow these laws. This means that science-fiction robots nowadays may break down or run wild because of an accident, but they will never revolt. By the time real life robots are smart enough to think of revolting, they will be built to obey Asimov's Three Laws or some similar fail-safe system.

Today's robots are not yet smart enough to need such safeguards. They can perform a few simple tasks on their own, such as opening doors and controlling switches. For more complicated tasks, however, they need the help of humans, either directly or through computers.

A good example of this are the "robots" we see at fairs, but these are not the true robots of science-fiction fame. They are automatons, machines that run by themselves: ➔

ROBOTICS

The most advanced of these are the lifelike performing figures such as Walt Disney Enterprises' Automaton-antronic creations. As realistic as these machines are, though, they are hardly portable, much less mobile. They require huge banks of computer-like relays to make them perform.

We seldom see the real robots or their drone forerunners because they are at work in laboratories and remote areas of this world and others. The robots perform tasks on push-button command from their human masters while the drones are remotely controlled by human operators much like puppets on strings.

These drones and robots substitute for living people in places and at tasks where it would be impos-

Inventor Tony Reichelt of Rutherford, N.J., has a 5-foot robot named Klatu which he sees as a prototype for a "domestic android" that he expects to begin producing commercially within two years. The robot will be able to greet guests, take their coats, serve them dinner, and clean up after they leave. It can also teach your children, make sure their grandmother takes her medicine, and keeps intruders away from the house. It even does windows. All for \$4000.

This isn't quite as far-fetched as it seems, although some people question whether it can be done soon and at that price. . . . These experts don't argue that Mr. Reichelt is wrong in developing a household robot, merely that he is premature.

—Wall Street Journal.

sible or dangerous for their more delicate masters to venture. Among these are the depths of the sea, the far reaches of space, and atomic

laboratories. These "teleoperators," as engineers call them, bear only a remote resemblance to humans.

Actually, remote manipulators, like Viking's, were old hat long before the first lander took off for Mars. When the first reactors began producing atomic bombs near the end of World War II, nuclear scientists quickly realized that they must have some means of handling deadly radioactive materials through thick walls.

The first remote manipulators were little more than remote controlled tongs. Later, engineers at the Atomic Energy Committee's Argonne National Laboratory developed a simple variety of remotely operated artificial hands called unilateral manipulators.

In the AEC booklet, *Teleoperators: Man's Machine Partners*, William R. Corliss explains how a unilateral manipulator works: "If you have ever tried to pick up a prize with one of those mechanical 'hands' (or buckets) at an amusement park, you have operated a unilateral machine. There is no sense of touch or, as they say in the teleoperator field, no *forced* feedback."

Ray Goertz and his associates at Argonne and John Payne at General Electric took the next step in remote-controlled mechanical hands in 1948. They developed bilateral manipulators; that is, teleoperators with forced feedback allowing the person to feel slightly what the mechanical arms were doing.

To use these "waldos," as the mechanical hands are sometimes called, the operator puts his fingers into one loop and his thumb into a ring. As he moves his thumb and fingers, rods and pulleys carry this motion to the pincer-like "hand" of the

Star Wars' Robots: More Fun Than Fact

The hottest new team in films since Redford and Newman is a pair of unprepossessing androids from the movie *Star Wars*. Artoo Detoo (R2-D2) and his sidekick See-Threepio (C3PO), who resembles a Space Age version of the Tin Woodman from *The Wizard of Oz*, are two robots with tremendous human appeal.

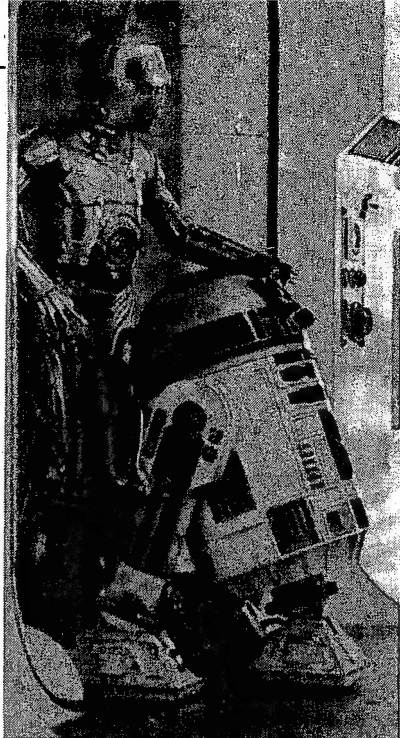
But do these two creatures really represent an accurate projection of the shape of robots to come?

Unfortunately, the consensus among scientists, as expressed by William M. Whitney of NASA, is that they provide "a very romantic but highly inaccurate view of the way robots will look and act in the future." Dr. Whitney is technical director of the Robotics Research program at the JPL (Jet Propulsion Laboratory) in Pasadena.

We have no need to make robots in the shape of men, Dr. Whitney points out, since the form of these thinking machines will be more accurately shaped by their specific functions. "We may have robots with three eyes or just one eye or perhaps an eye located elsewhere, a sensing device, that will enable it to see a wide field of vision." These robots, he adds, also may have one arm or half a dozen arms, again depending upon the role they will play.

waldo. The feedback from the waldo makes it seem to the operator as if he is working in heavy mittens. Nevertheless, skilled operators can perform very delicate tasks with these mechanical hands.

The next step toward robots was taken by Goertz and his fellow



R2-D2 and C3PO are emerging as heroes of the new robot cult.

Another myth that *Star Wars* helps to reinforce is the friendly image of the robot as household pet and factotum. Dr. Whitney, however, sees it as playing a much more valuable role in the future, substituting for man in firefighting, mining coal, helping to deactivate bombs, and working in other dangerous occupations. Above all, he sees robots playing an important part in our exploration of space.

workers at Argonne, who replaced the rods and pulleys of the waldos with electrical connections in 1954. This electrical connection could become a radio link simply by using radio transmitters and receivers.

This meant that the control unit, called master, need no longer be

ROBOTICS

separated by no more than a few feet from the remote unit, called a slave. The slave could be as far away from its master as the moon. Indeed, this is what was done by NASA with its Surveyor moon-landing robots in 1966 and 1967. A similar test project is now being carried out by the Russian Lunakhod moon roving robots. Television cameras serve as the "eyes" of these space robots to tell what they are doing.

The Lunakhod can only rove about the moon reporting what it sees back to earth. Some slave unit artificial hands, however, have been mounted on small tractors so that they can perform and look somewhat like science-fiction robots. When mechanical legs, or "pedipulators," controlled by the operator's legs, are fitted to a slave unit it will be able to walk and climb where even a treaded tractor could not go.

Actually, though such slave units look like robots they are actually drones. That is, they cannot think for themselves but depend on their human operators to take care of this for them. About the smartest of these slave units is the Lunakhod, which can dodge obstacles that its masters back on earth have failed to notice.

All a drone needs to become a true robot, however, is addition of a portable computer. Just how smart they would then be would depend on the computer's compactness and on how much weight and bulk the machine could carry while performing its work.

The computer need not be extremely large, however, if micro-electric circuits like those in pocket calculators are used. These instruments use tiny chips about one-eighth of an inch square which hold over 11,000 electronic elements.

Another possibility would be to

Coming: Your Food, Courtesy of a Robot

Robot farmers?

Consider a modern poultry "farm" . . .

In a huge, windowless building, in rows of cages, live thousands of hens. Electronic monitors control the light, ventilation, temperature, and humidity. Conveyors automatically distribute feed and water. Newly laid eggs roll onto moving belts that transport them to collecting stations.

Similar robot "beef factories" already are operating in Wisconsin.

Engineers at the University of Saskatchewan are developing a robot tractor that uses electronic sensors to follow a guide furrow around a field, meanwhile digging a new guide furrow for its next pass.

In another system, a manned lead tractor guides three or more robot tractors in tandem.

A Ford Motor Company study of farming in 2000 A.D. predicts that most farm work will be done by such robots, from plowing to reaping. The machines will follow buried wires, furrows, or field patterns stored in computer memories. Some will traverse field-spanning mobile bridges.

At Kennedy Flight Center, International Harvester recently exhibited a robot combine. The machine's 30-foot-wide front section automatically gathers, threshes, separates, and cleans the grain, then blows it back into a transport unit. Full, the transporter detaches from the com-

link the computer to the master unit. It then could be as large as required and control a number of slave units. Such a linkup is in use at Chevrolet's Vega plant in Detroit, where a double row of computer-controlled drones perform practically all welding on each car on the assembly line.

Some steps have been taken toward giving drones the electronic brains they need to become robots. Yet today's mobile thinking machines do not approach the human or super-human intelligence of science-fiction robots. About the best done so far was an automaton with the IQ of a one-celled microscopic animal. This tub-like robot was developed by a team of scientists a few years ago. It wandered around the laboratory dodging obstacles as it searched for an electric outlet at which to recharge its batteries.

As anyone who has ever stumbled knows, two feet are a rather

bine and rolls off to the silos, dumps the grain, then returns.

The American Society of Agricultural Engineers heard Donald Sisson, product manager for Ag-Rain, Inc., describe tomorrow's irrigation systems:

"Picture an underground piping system with water outlets at predetermined points, then visualize a robot that moves through the air according to a predetermined program," he said. "At each water outlet this irrigation robot will sit itself down, much as the moonlander does, then automatically probe for soil moisture content and other key soil analyses as it connects itself to the water supply."

Less colorful than old Silas, perhaps. But mighty efficient.

In *Build Your Own Working Robot*, author David L. Heiserman provides step-by-step instructions—plans, schematics, logic circuits, and wiring diagrams—for making a mechanical pet. Heiserman calls his "Buster," and Buster will bring coffee and the morning paper. He'll forage for his own "food" (a battery charge) and scream when he can't find it.

Build Your Own Working Robot is not a project for novices; a prerequisite is a background in basic electronics. Mr. Heiserman describes it as "an ambitious undertaking." The 16 chapters (heavily illustrated with diagrams) range from "The Buster Concept" through "Steering Control Logic" to "Hunger Interface."

Published at \$8.95 (\$5.95 soft-cover) by TAB Books, Blue Ridge Summit, PA., 17214.

unsteady way of getting around—four are much better. So, in devices such as the still experimental walking truck, the operator's arms control the machine's forelegs while his legs control the machine's rear legs. For a task where hands would be needed, the drone could be given two pairs of legs controlled by the operator's single pair. With the addition of remote manipulators the result would be a mechanical version of a centaur.

Clearly, the walking truck is much stronger than its human operator. Teleoperators can also be used to give a human a set of mechanical muscles to do things otherwise far beyond what he ordinarily could do. One such Man Amplifier is GE's Hardiman.

Besides amplifying the strength of normal people, teleoperators also are used as artificial limbs for the

ROBOTICS

handicapped. They have not yet reached the level of those used on television's "Six Million Dollar Man" (perhaps because of the price tag), but they come close.

Other drones and robots also are aiding humans in living better lives. Like Walt Disney's autoanimatronic figures, these machines look and act almost exactly like human beings. They perform more serious tasks.

Two of these helpful machines (or, rather, one and a half) are at NASA's Space Flight Center in Houston. The half robot is ED (Electronic Dummy). ED is the bust of a hairless male mannequin mounted on an electronic control box. Inside this dummy are microphone ears and a speaker mouth used to test earphones and microphones for astronauts.

The other robot is a Powered-Driven Articulated Dummy (PDAD). This 230-pound robot is actually a super clothes dummy used to test new kinds of space suits. Its height can be adjusted from five inches to six feet two inches. It also bends its joints from fingers to toes to test the space suit's freedom of movement.

Robots that closely resemble human beings also are being used for medical students to practice on before they are ready for human patients. Such machines imitate the breathing and other actions of a living patient. A computer causes the robot to react to treatment as a human would. Medical complications for the students to deal with can also be introduced by a computer technician.

So far, though, no one has made a robot or a drone that closely resembles a human being, has all the responses of a human, and is com-

A Million-Dollar Robot

"AROK," a 6-foot-8 robot with an insurable value of over \$1 million, is the invention of Benjamin Skora of the Chicago area. Powered by two 12-volt auto batteries in his feet, he toots around at two or three miles an hour doing such chores as vacuuming the carpet, walking the dog, carrying parcels, serving drinks, and answering the door.

He communicates through three antennae in the head that receive and transmit signals through FM wavelengths from a control panel; he functions with the help of 15 motors connected to 35 relays and hundreds of solid-state ICs and transistors. A memory tape enables the recording and programming of the telemetered routine to be repeated at his master's will.

To add an unusual lifelike simulation, AROK has a rubber-mask face on a molded fiberglass skull; the rubber glove-clad hands are on arms jointed at shoulder, elbow, and wrist. He's a descendant of a telemetered system that Mr. Skora developed in 1949 to start his car by remote control in wintry weather. —Linda Folkard-Stengel,
In Interface Age

pletely mobile. This should be possible at least in the form of a drone. The reason it has not been accomplished is that the mobile robots do not need to resemble humans, and those that resemble humans need not be mobile.

At present, robots are at about the same stage as electronic calculators' were some ten years ago. That is, they are being used a great deal in laboratories and factories but, with very rare exceptions, not yet in our homes. Specialists in the field suggest that ten years from now robots will be as common as calculators are today. ■

As Federal dollars for basic investigation fade, university scientists turn toward industry as a means of solving the

RESEARCH CRUNCH

by Marvin Grosswirth

The roster of a generation of Nobel Prize winners underscores the high level of scientific research in America. Out of a total of 178 prizes awarded in the sciences between 1943 and last year, Americans took 86. All Nobel Prizes in 1976 in the sciences went to Americans.

Most of this country's Nobel Prize winners conducted their research at major American universities. Since the end of World War II, we have equated important scientific research with academic institutions.

But now, academic research seems to be hitting the skids, and while the downhill slide may be at a barely perceptible rate, it threatens to accelerate in the near future.

That dire prognosis derives from a two-year study conducted by two political scientists, Bruce L.R. Smith of Columbia University and Joseph J. Karlesky of Franklin and Marshall College. The survey, funded by the National Science Foundation, resulted in a detailed report entitled *The State of Academic Science* (New Rochelle, N.Y.: Change Magazine Press, 1977).

"Although American science and technology remain generally strong,

competitive and dynamic," say Smith and Karlesky, "sufficient warning signs of emerging problems have arisen to alert policymakers to ensure that these downward trends do not worsen."

Predictably, most of the trouble is caused by money—or the lack of it. In 1962, the Federal Government—the major source of funding for scientific research—contributed some 62 percent of all research and development costs. By 1976, the government's share had declined to an estimated 53 percent. In terms of "real" or constant dollars, the difference appears minimal: the government's share of university expenditures for research and development in 1966 and in 1976 were about the same—in the neighborhood of \$1.8 billion. Significantly, however, the allocation of those funds has changed dramatically.

"National *basic* research expenditures have decreased more sharply. . . . Federal constant dollar expenditures for basic research declined by an estimated 15 percent between 1968 and 1976," contends the study. More and more, government funds are earmarked for specific projects: "Consequently, although support remains at high levels, the atmo-

ACADEMIC RESEARCH

sphere within which American science is conducted has changed from one of rapid growth and expansion to one of stability and even some contraction." That stability and contraction are manifesting themselves in ways that, if allowed to continue, could bring scientific research in the halls of academe to a grinding halt.

One "persistent and critical aspect" of the money crunch is the inability of research facilities to stay current with instrumentation. Not enough money is available to purchase new equipment, to replace obsolete equipment, or to maintain instruments in proper working order. "The weakening financial base of the universities," states the report, "contributes to the problem, as do government policies and the short-term incentives for university researchers."

Smith and Karlesky point out that so-called "middle-range" instruments have a "research life of three to six years," and those instruments are "wearing out and becoming obsolete." But when funds become scarce, the tendency is to allocate expenditures for personnel rather than for equipment.

PARADOXICALLY, the lack of up-to-date instrumentation can affect decisions about personnel. The chairman of the chemistry department at a midwestern university commented: "The cost of acquiring and maintaining research instrumentation not only has hindered research activities but is an important factor in regard to additions to the department. I'm hesitant to hire young staff because of the instrumentation requirements."

But non-functioning or obsolete equipment is not the only obstacle in hiring young scientists. During

the 1960s, in the wake of the Soviet Union's Sputnik I into outer space, America underwent a kind of science orgy. "One consequence of the unprecedented expansion of the 1960s," comment Smith and Karlesky, "has been that many departments now have large numbers of relatively young tenured faculty. However, with little or no expansion ahead and replacement demands relatively low, the median age of university scientists will rise steadily in the next decade . . . The problem of limited openings for young scientists in academic employment is genuine."

Allan M. Cartter, in his book, *Ph.D.'s and the Academic Labor Market* (New York: McGraw Hill, 1976), predicts that during the 1980s, "probably less than one in five Ph.D.s are likely to find academic positions." Not until 1990, according to Cartter, is there "likely to be a significant recovery in the number of academic openings available . . ."

As federal funds dwindle, corporate coffers begin to look better. Universities, report Smith and Karlesky, "are seeking to rediscover their ties to industry . . . faculty and administrators seem considerably more interested in strengthening their research ties to the private sector than they were five years ago. This appears especially true in the most prestigious universities, at which anti-industry protests and attitudes were strongest in the late 1960s."

A striking example of company money financing university research is the deal between Monsanto and Harvard. The chemical giant will pay out up to \$23 million over a 12-year period (which began in 1975) for biological and medical research

Median age of university scientists is likely to rise through the 1980s, with few opportunities for newcomers.

at the university. In return, Monsanto gets "exclusive licenses for a period of time to inventions made in connection with Monsanto-supported research."

MEANWHILE, over at the Processing Research Institute (PRI) of Carnegie-Mellon University, "between January, 1972, and June, 1975, 26 firms and industrial associations paid approximately \$800,000 to support 34 separate research projects." An additional half-million dollars came from a National Science Foundation grant. Involved in the projects were companies such as Exxon, Westinghouse, DuPont, Xerox, Ford and Alcoa. Supposedly, the PRI program used the projects as a means of involving graduate students in problem-oriented research geared to industrial needs, and "is not aimed at improving productivity in participating firms, nor is it addressed to any specific market failures." It does, however, demonstrate how industry can influence the direction of scientific research.

Ties between industry and academia are, in Smith's and Karlesky's views, still far from strong, but "both the industrial and the academic sectors have shown a strong desire to rectify their neglect of each other in the recent past and to establish better relationships." One result of those better relationships could be the shoring up of a portion of the scientific research structure that seems closest to imminent danger.

According to the study, so-called "second-rank" departments and in-

stitutions show the greatest signs of deterioration and inevitable collapse: "The realities of modern science—the cost and increasing complexity of experimental research at the frontiers of knowledge—also create strong pressures on the system to have fewer departments fully prepared to conduct research of the highest development."

So what? It could be reasoned that a few high-quality departments and institutions could avoid redundancy of effort, provide more efficient allocation of increasingly-shrinking funds, and eliminate the dissipation of badly needed qualified personnel. Unfortunately, however, such stratification is likely also to result in a severe reduction in the breadth and scope of scientific research. Furthermore, as the number of research centers decreases, so does the competition between them, forcing the nation to rely "on a narrow base of dominant centers."

SMITH and Karlesky also fear that the concentration of scientific research into a few "dominant centers" will diminish the role of other universities as disseminators of knowledge to the public. Included within that public are students who could be deprived of "exposure to the most creative thinking available." Also, they have "no doubt that the cultural life of a community could suffer if its higher education institutions lacked a research capability." But, perhaps most important, the broad base of inquiry that "has traditionally been

(Continued on Page 75)

With nothing to do except roll around Heaven all day, our **SUN** is creating doubt about its constancy . . . and reliability as a source of energy for Earth

by James Mullaney

That magnificent life-giving orb of day that we fondly call the sun is our home star—one whose prodigious outpouring of energy always has been confidently assumed to be as constant as the rock of Gibraltar. This, despite the fact that many stars are known to vary in radiance with time, and often rapidly so.

Each second our sun converts some 4.3 million tons of its mass into energy equivalent to that of millions of hydrogen bombs. Astronomers and astrophysicists believe that this colossal thermonuclear furnace has operated at such a rate for most of its five-billion-year history and that it can continue to do so for a similar period into the future.

Recent observations, however, from a number of quarters now are casting serious doubt about the sun's constancy and even its energy source.

Least spectacular of these is a gradual 5 percent brightening of the outer planets Uranus and Neptune over the last few years, as detected photoelectrically at the Lowell Observatory in Arizona.

The sun itself is simply too dazzling for accurate monitoring of its luminosity by the direct means used on stars. Instead, sunlight reflected to us from distant worlds like Uranus and Neptune serve as natural

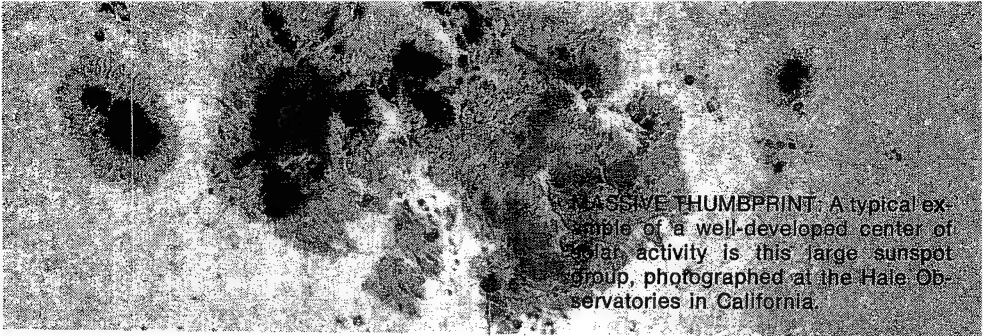
monitors on solar activity. After we take into account all known intrinsic effects from the planets themselves, the observed brightness increases appear to have their source in the sun.

Another indication that all is not well with our sun is the puzzling current scarcity of sunspots or solar storms on its visible surface.

These features long have been known to vary in numbers over an 11-year activity cycle (more accurately, a 22-year magnetic cycle). We now are nearing another sunspot maximum, expected sometime in 1980.

The trouble is that, with this peak no more than three years away, the sun should be peppered with spot activity—yet few sunspots are to be seen! Recent reports from solar observers indicate their frequency may now be on the increase, but sunspot numbers still are considerably below that expected at this period of the cycle.

A link may also exist between the current lack of sunspots and recent unusual events on the giant outer planets of the solar system. In addition to the brightening of Uranus and Neptune already mentioned, the planet Saturn is displaying obvious colorations in its normally pallid equatorial regions. On the other hand, the cloud belt struc-



MASSIVE THUMBPRINT: A typical example of a well-developed center of solar activity is this large sunspot group, photographed at the Hale Observatories in California.

ture of Jupiter has had a "washed-out" appearance in this apparition, and the famous Red Spot has been "missing" for more than a year.

This latter feature is an enormous cyclonic storm in the dense Jovian atmosphere. Its surface area is greater than that of the earth and it has a distinct pink to brick-red hue most of the time. Known since the earliest telescopic observations of the planet, the Red Spot has faded from view on occasion in the past. Observers, however, generally agree that in at least the last quarter-century it never has been so conspicuously absent as at present.

The point here is that the sun is an important contributor to the driving force behind the "weather" on those planets. It is possible that unusual events like those cited may well originate from changes within the sun itself? What sort of changes take place?

One change, perhaps of greatest concern to scientist and layman alike, is what an eminent cosmologist, Sir Fred Hoyle, has called "one of the most baffling problems of modern astronomy."

This is the unsolved mystery of the missing solar neutrinos.

The neutrino is a massless, uncharged subatomic particle that travels at the speed of light. It interacts so weakly with ordinary forms of matter that it has been said that

a neutrino can penetrate a light-year of lead!

It is a foundation-stone of modern astrophysics that the sun and stars shine by thermonuclear reactions of one type or another. Most common of these in relatively cool stars is the well-known "proton-proton cycle" (conversion of hydrogen to helium), a necessary by-product of which are neutrinos. If, as everyone believes, the sun generates its energy by this reaction, it should be giving off copious quantities of neutrinos.

Careful experiments conducted by scientists of the Brookhaven National Laboratory for more than a decade have failed to find solar neutrinos in the expected numbers. The heart of their detector is a 100,000-gallon tank of dry-cleaning fluid, located nearly a mile below ground in a gold mine at Lead, in South Dakota. This unusual device was placed there to shield it from cosmic rays and other types of radiation. Only the undaunted neutrino is able to reach its reaction chamber.

Although this experiment has, in fact, detected neutrinos emitted by the sun, their numbers are strikingly below what established nuclear theory predicts should be found.

This has led to what one authoritative source in the field describes as "a deepening scientific crisis." ➔

SUN'S FUTURE

Several possible explanations are advanced for this serious discrepancy between theory and observation. One is that some basic misunderstanding exists in either neutrino physics or our generally accepted views about the sun's interior. Perhaps too, some hidden difficulty resides in the present experiment itself, though most observers consider this to be unlikely. Some even have suggested that the sun may not be shining by thermonuclear reactions after all, but rather by some other process, such as Helmholtz contraction (an idea popular with astronomers a century ago).

Most profound in its implications for life on this planet is the disturbing possibility that the sun has—at least temporarily—turned off its nuclear fires. And should this have in fact happened, we would find out about it first from the neutrinos.

Most forms of radiation generated within the sun require millions of years to move the relatively short distance from the core to the surface. This is because of solar capacity—scattering, reflection, and other types of interaction between matter and energy. Once having arrived at the sun's surface, this radiation reaches the earth in only eight minutes. In contrast, the unsociable and unimpeded neutrinos require only three seconds to reach space from the core, then the same eight minutes to get here and into the cleaning-fluid trap. Thus, neutrinos should allow us to monitor activities at the sun's center *now*.

Hoyle and others suspect that the present level of solar activity may be lower than the sun's long-term average and that it could drop off even farther. They speculate that the

Ice Age sequence of the past million years may be far from over—that the most devastating disturbances still lie ahead.

Recent climatic studies convincingly show that just a 2 percent decrease in the solar radiation we receive would lead to total glaciation of the earth. Although major changes in the sun's luminosity and energy output seem unlikely to most experts in the field, no one can be sure it will not happen.

Clearly, the sun is of immense importance to mankind—indeed, to all life on this planet. That it will change is certain. But significant change should be billions of years in the future—not now! More and more scientists are addressing themselves to the various aspects of the problem. They will have to understand subtle but important links to the outer planets: If the sun's central fires are banked, why have Uranus and Neptune *brightened*? How much time does it take for a central turn-off to show up on the surface? Will it be a cooling of the surface or a heating? Ideas of stellar evolution indicate that *more* radiation results from a decrease in the hydrogen burning. But these ideas are based on now conventional theories of thermonuclear reactions—reactions that are expected to produce all those neutrinos. And we don't see them.

What is wrong?

The detection of apparent paradoxes in nature is an indication that we have a gap in our knowledge of physical laws. This present puzzle is not really expected to be the end of the world, but, we may hope, the beginning of our move in the right direction for further understanding of our sun and the rest of the universe. ■



PLANET OCEAN

*Director Erik Speyer
and a guide at the
Gulf Stream exhibit.*

Continued from Inside Front Cover

Planet Ocean is the new oceanography exhibition out on Virginia Key just offshore of midtown Miami. Opened early last year, it is drawing some 300,000 visitors annually—although still not totally completed.

The 100,000-square-foot windowless building, looking somewhat like a cubistic dune among the coconut palms and casuarina pines along Biscayne Bay, houses several "theme areas" that dramatize the history and functioning of the oceans. Each is presented in three successive states, designed for differing levels of visitor interest, and employing imaginative audiovisual and participatory displays.

Presented as a sequence—a story—in the approximate order of their chronology and relationship in nature, the seven exhibit areas are: the Solar System, the Ocean Reservoir, Birth of the Oceans, the Reservoir of Life, the Weather Engine, the Restless Sea, and lastly, Man in the

Sea. Each theme is dramatized in its introductory show—theater presentations using films and striking audiovisual effects. The visitor then exits to an area of ancillary exhibits that expand on the particular theme in more detailed fashion.

Planet Ocean's creator is F. Walton Smith, president and founder of the International Oceanographic Foundation, a nonprofit international membership organization that financed and built the facility, with aid from various corporations, foundations, and individuals. It operates entirely on admission fees and IOF funds.

Dr. Smith skirts the word "museum" in favor of "ocean science showplace."

"We've accumulated considerable expertise in making entertainment and reaching people in creating Planet Ocean," he notes. "I think we have an idea where that thin line is between what the average person will listen to and what is pure science."

The first theme area, the Solar System, illustrates well the museum's concept of trying for a wide range of interest levels. The entry show, a 14-minute, wide-screen movie, is an Academy Award nominee called "The Unlikely Planet," that describes during an exciting

Excerpted, with permission, from "Planet Ocean," by Joseph M. Pereira, in The Orange Disc, magazine of the Gulf Companies, July-August, 1977.

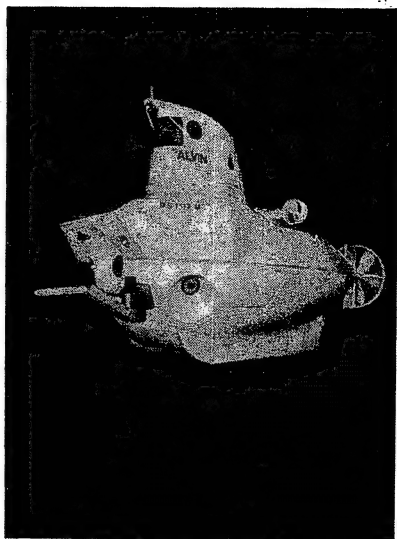
PLANET OCEAN

space voyage the solar system and earth's place within it as its unique ocean planet. (Produced by the special effects people who worked on the film "2001," this color movie has won several international festival awards apart from its Oscar nomination.)

"When you leave the film theater, you walk into the 'Properties of Water' ancillary area," explains Erik Speyer, Planet Ocean's executive director, who collaborated in the design and supervised creation of all shows and exhibits. "Exploring the properties of water are 20 exhibits, of which 16 involve participation—pushing buttons, investigating, feeling, reacting."

You enter a black-walled cavernous hall where ceiling spotlights pool onto individual exhibits, arranged as islands and along the walls. Graphics and marquee-style bulbs draw you past partitions framing a curvilinear seven-foot-high iceberg. It's usually covered with touching hands—not all of them children's. Next door, side-by-side plastic cylinders hold hundreds of Ping-Pong balls that whirl violently at your pressbutton demand, upward in one cylinder, falling in the other. A recorded voiceover explains this vivid illustration of oceanic surface evaporation and condensation—and how weather patterns result.

Nearby, a marionette-like diver doll jauntily seated along the edge of a large vat of water dangles his legs over the side. Viewed from above the water surface, he appears legless; but through the vat's side you see normal legs, and understand about refraction of light through water. Fifty other theme-one ancillary exhibits go on to show how



The "ocean science showplace" has a varied roster of graphic exhibits.

sound transits water, why the ocean is blue, what capillary action is, the nature of watery erosion, corrosion, ionization, conductivity, and specific heat—in sum, all about water as a liquid, gas, and solid.

The whole enterprise seems an especially timely combination of education and entertainment distilled from years of conceptual planning by Dr. Smith.

"The IOF (International Oceanographic Foundation) was founded in 1953," he recalls, "with the idea that the general public reads a lot of exaggerated stuff about the ocean with very little objective content. I felt it particularly important that people be exposed to more authentic information. It isn't the scientists investigating the environment who make the decisions, it's the Congress; it's federal commissions; it's state and local government, sometimes pressured by special interest groups.

"So I see it as very important that the general public know something about the ocean and what it is. Not superficial ideas, like the wicked shark and brave diver. But the ocean as an extraordinarily important energy system—the principal source of energy on earth, and therefore a vitally important place. Mankind, and all living creatures, are after all part of this oceanic energy system. We ourselves are devices in which energy is transformed, manifesting itself as life."

Not unexpectedly, the builders of Planet Ocean have encountered, in translating often erudite natural laws into popular-appeal exhibits, some offbeat operational—and human—impediments. Ping-Pong balls, representing molecules of water, repeatedly blown about in transparent plastic tanks, were cracking, and the gas with which the balls are charged to maintain firmness coated the tanks' clear walls with milky film. "It took us a while to figure out where the coating could be coming from in a sealed exhibit," according to Mr. Speyer.

Then there was the ten-year-old mountaineer who joined his enthused dad in scaling theme one's seven-foot-high iceberg. Happily, it's fortified against such assaults with massive interior copper coils that also maintain its frozen mass.

Theme three's theater presentation, "Birth of the Oceans," relies on special effects in, on, and around the five 12-foot screens. The 19-minute animated film incorporates strobe and wash lights, quadraphonic sound and vibration devices within the 150-seat theater.

As volcanoes erupt on screen, seats tremble and pulsing crimson lighting flashes on all sides. Viewers rate it as an edge-of-the-seat, sus-

penseful account of the earth's creation and passage through geological history up to the climactic moment of man's appearance.

The ocean as a reservoir of plant and animal life, and as both contributor and recipient of violent climatic forces, occupies the next three themes, still to be completed. Innovative microscopic film strips and slides offer a glimpse of the fantastic geometric shapes and colors of plankton surrounding the visitor.

Numerous moving models demonstrate not so much how sea life looks as how it works—how it cycles fertilizer into plants, plants into food for fish and fish as food for man, all to be broken down by bacterial decay to fertilizer again; how fish make sounds, and porpoise

Seven themes emphasize idea of energy pathways created within the ocean . . . the basis for all forms of advanced life.

sonar works in detecting obstacles or food; how a shark detects its prey thousands of feet away; and how whales, fish, or turtles are able to navigate along established migratory paths. And there's the role that the ocean and ocean life have played in producing oil deposits.

In theme six, you learn how the wind system returns energy to the ocean by driving the surface waves and currents. This is dramatized by a visit to the bridge of a large ship. Looking through the wheelhouse windows, you see the bow plowing through increasingly violent wave action. Green solid water breaks over the bow. The bridge, poised on a mechanical pivot, is rocked to

PLANET OCEAN

simulate pitching movement of the ship; introducing the Restless Sea.

The associated areas explain the forces of waves, currents, and tides, all of which help to prevent the oceans from becoming stagnant, lifeless ponds.

The section on energy from the sea explains why the ocean is the earth's greatest solar energy reservoir, and how the ocean has channeled solar energy to create all earthly life and other energy forms.

"The energy of solar radiation is a sufficient, steady income for man, if properly harnessed," notes Dr. Smith. "Coal and oil are not continuous . . . they are part of the continuous solar energy that millions of years ago was trapped by plants, fossilized, and stored—a bank deposit now being spent at a reckless pace. Solar energy falling on land is very thin, so it's much more expensive at the moment to trap than to drill for oil and mine coal. In the ocean, solar energy is concentrated in the form of heat. The surface temperature is many degrees higher than, say, 1,500 feet below. This represents a concentration of heat—or energy—that, per unit area, is 25 times greater than solar heat on land, even in the hottest climates. These are the sorts of things we want people to know about."

Summing up, he explains: "We keep the idea of energy throughout as the central motif of our seven-theme story line. Not many people have been presented with the idea of how closely tied all the systems are—this fantastic web of energy pathways created within the ocean and kept alive by it, the basic prerequisite for the appearance and evolution of advanced forms of life over our entire planet." ■

by Joseph E. Brown

One blustery day last December, the timeworn, trouble-prone, 30,000-ton tanker *Argo Merchant* plowed onto a shoal east of Nantucket Island. Pounded mercilessly by heavy waves, the vessel broke in two, spilling an estimated 7,600,000 gallons of crude oil into the sea.

Although the tanker's 38 officers and crewmen were rescued unharmed, the potential environmental threat of her spewing cargo was, and continues to be, catastrophic. Carried by wind-driven currents, the oil soon was observed to be spreading over a section of the Atlantic 50 miles wide and 150 miles long. In a few days, it neared Georges Bank, site of a major fishery that provides jobs for 30,000 people, and home of the great humpback whale, gray seals, shellfish, and many other organisms.

Working day and night, harried cleanup crews could not check the advancing oil slick, which contrary to early fears, did not sink but two months later instead congealed into tar balls. Carried by the mighty Gulf Stream, the tar balls began seeking new targets thousands of miles away, in Iceland, perhaps, or the Azores. No one knows when the *Argo Merchant* oil will dissipate; some scientists fear that, like the storied *Flying Dutchman*, it may wander ghostlike around the Atlantic for years.

Satellites, radar, tv, aircraft data banks, and infrared gadgetry: all are being recruited against the creeping damage of

OIL SPILLS

but human failure is in the scales, too.

Oil contains substances that are highly and lastingly toxic. Added suddenly to existing stresses in the ocean, it can literally sterilize. Unseen by surface observers, it can change the composition of aquatic communities, imperil the ability of certain organisms to survive, interfere with vital life processes that affect behavior.

Floating oil destroys phytoplankton, the primitive plant life that generates most of the earth's oxygen. "Destroy phytoplankton," explains Professor Jacques Piccard, the noted deep sea explorer, "and the entire marine cycle is fatally disrupted."

Oil distillates such as kerosene and gasoline are as hazardous in the sea; instead of floating, they sink rapidly to the bottom, killing as they go.

For all their potential destructiveness, however, tanker spills and offshore accidents account for only a fraction of the oil and other hazardous materials that each year run up staggering cleanup bills, befoul our harbors, bays, estuaries and oceans, waste precious natural resources, and threaten human health and safety.

According to a study by the Academy of Sciences, tanker accidents (as opposed to intentional—and illegal—bilge cleaning, de-ballasting, and tank pumping) in fact account for only 4 percent of the 50 million barrels of oil introduced into U.S. waters each year. Spills from off-

shore platforms add up to an even smaller fraction: 2 percent; of the thousands of wells drilled off our coasts since the 1940's, only four blowouts were classified as "major."

By far, the majority of pollution—more than 90 percent—originates from sources that never make headlines. Sea floors naturally seep oil, oozing unchecked for eons, accounting for some 10 percent of "spilled" oil. River runoffs contribute another one-quarter. Municipal waste, industrial discharges, and rain-borne materials add 10 percent each.

It is the *accumulated total* of these "drip by drip" pollutants, added to the 13,000 accidental (and mostly preventable) spills big and small each year, that creates such staggering problems.

Economic Nightmare

For instance, nearly 20,000 oil and gas wells are at work off American coasts, and an estimated 3800 oil tankers of 6000-ton displacement or larger are in worldwide service. Hundreds of additional wells will be needed when U.S. offshore production pulls into high gear, and tankers, accounting for fully 42 percent of the Free World's total gross cargo tonnage, are becoming both larger and more numerous.

On a dollar basis, the unchecked

OIL SPILLS

increase in oil spills is an economic nightmare. A single 500,000-gallon spill last June involving a barge accident in the St. Lawrence River is typical: it cost no less than \$8 million to clean up. Some spills run up bills of \$1,100 per barrel lost. And even these figures may not begin to reflect the true cost of oil spills. Using a computer model, a British Petroleum scientist recently suggested that when *all* costs are added in—"third party" liability awards, indirect environmental loss, for instance—cleaning up men's pollution actually may amount to 100 times the value of petroleum lost.

Given the seriousness of the problem, what is being done about it? At this point, many projects and devices are being used to help prevent, contain, and clean up spills.

While only the most optimistic environmentalist would suggest that zero risk can be achieved as long as oil production and transport increasingly involve the seas, a spate of laws since *Torrey Canyon* have aimed at punishing spill violators, improving safety equipment, and enlisting international cooperation.

Electronic Watchdogs

Cornerstone of those new laws is the Water Quality Improvement Act of 1970, which makes it illegal to discharge oil in American waters. Even a Sunday pleasure yachtsman technically risks \$5000 worth of fines if he so much as pumps a quart of oily bilge water into a navigable waterway. The Coast Guard admits its current manpower of 44,000 is stretched too thinly to bag all but the biggest game.

At the same time, a whole armory of electronic devices has been developed to keep watch on increasing

oil traffic, to detect accidents early, and to facilitate cleanups when they occur. A Massachusetts firm has designed a monitor, operating on an infrared principle, that can detect spills or leaks as small as one part per million, without sampling, testing, or water contact. Employed by both refineries and aboard tankers, the gadget triggers a noisy alarm if oil is detected.

With a memory bank cataloging data on more than 900 chemical compounds, the Environmental Protection Agency (EPA) uses a computer retrieval file to provide immediate information on how reported spills can be most efficiently handled. "The information," explains Jean Wright, director of the agency's Oil and Hazardous Materials Technical Assistance System (OHM-TADS), "has been carefully compiled from scientific literature. Even applied substances of unknown material can be identified. Give us the color, odor, and density, and chances are that within 15 minutes OHM-TADS's computer will suggest several cleanup candidates."

Coast Guardsmen are as optimistic over a spill surveillance system as sophisticated; abbreviated AOSS (for Airborne Oil Surveillance System) it uses such Space Age gadgetry as side-looking radar and TV scanners to monitor oil tanker traffic and other potential sources of spills. Recently concluding its evaluation tests, AOSS first proved its worth in 1975 when, beamed down from a patrol plane flying off the California coast, it fingered a tanker clandestinely discharging oil. Result: a \$4000 civil penalty assessed against the offending shipping company.

Some spills are not spotted, however, until the culprit is miles away.

Predicting Argo Merchant's Damage

"The Governor's Office called at 8:30 in the morning.

"They wanted to know where the oil was going. And how it might affect the state of Rhode Island.

"Within hours," recalls Dr. Malcolm Spaulding, an associate professor at the University of Rhode Island, "we were able to advise them that if the oil sank, it would probably come up on Rhode Island and Martha's Vineyard beaches by early April. But not to worry if it stayed on the surface. In that case, it would probably go offshore."

Only a few months before, the university had been given a grant by the Energy Research and Development Administration (ERDA) to study the treatment of oil spills. And, in short order, the Ocean Engineering Department had developed a simple computer model on the Academic Computer Center's IBM System/370 Model 155 to predict the surface drift of spilled oil.

Even before the ship broke up, the scientists rushed their computer model to completion and put it to work to tell them two things:

- Was the spill heading toward shore, endangering sensitive breeding areas for marine life as well as the state's beaches?
- If the spill was moving away from land, was it heading toward Georges Bank, a major fishing ground, or toward the open ocean?

Within 24 hours of the breakup, the department was able to make

two kinds of computer predictions that were repeated at five-day intervals, for the next 30 days.

The first, based on 10-year wind averages for December and January and tidal currents drawn from ocean survey charts, told what to expect—if past trends were repeated.

The second, based on actual wind measurements and slings of the spill, told the scientists how well their historic model was doing—and how it should be modified. As it turned out, the two forecasts were fairly similar to each other.

"We did quite well with the surface prediction," says Dr. Spaulding, "but we also realized just how much we did *not* know."

Dr. Spaulding and other scientists at the university are working on more mathematical models that will, for example, tell how oil gets into the water column, how oil travels after it gets below the surface, and how different types of oil behave in seawater.

"Two years from now," says Dr. Spaulding, "we will have a much more exact grasp of what will happen—down to an indication of the impact of the spill on marine life.

"Still more important, we should be able to know whether or not to treat a particular spill with dispersion agents in order to minimize damage."

—Geoffrey D. Austrlian, in *Think* (July/August 77).

To better identify them, the Coast Guard is enlarging its forensic "oil fingerprint file," a sort of computerized detective bureau that classifies and "banks" several hundred types of oily substances. Matching samples from the data bank with those picked up from a "mystery spill,"

the Coast Guard often can track down the source weeks later. In 1975, for instance, the source of a spill in the Florida Keys (which cost \$367,000 and 24 days to clean up) was traced to a bilge-flushing tanker that had passed by many days earlier. ➔

OIL SPILLS

And by next year EPA expects to be monitoring spills from a position even more literally "far out"—the space-orbiting Nimbus satellite.

Preventable Problem

Obviously, small spills in protected areas can be controlled more easily than large ones in the open sea. In shallow water, a dam of baled hay or a hastily-rigged, chickenwire fence impregnated with cotton often may do the trick. But in the ocean, and in spill areas where cleanup crews face the harshest whimsies of nature, the challenge can be overpowering. Aware of this, a New England shipbuilder offers a fleet of vessels tailored for this specific task; they range in size up to a 110-foot self-propelled ship whose whale-like mouth can gobble up and store 1100 gallons of oil per minute up to a capacity of 35,000 gallons. All told, the cleanup equipment owned by the oil industry and its co-ops amounts to an inventory investment exceeding \$14 million, and it's increasing steadily.

Can oil spills ever be stopped? "Unfortunately," comments Coast Guard Admiral Owen W. Silber, with realistic candor, "there is no way to totally prevent oil spills." As long as we rely upon fossil fuels in ever greater quantities, such predictions will hold true. Equally sad is the fact that most could be prevented. The *Torrey Canyon* disaster has been blamed on the captain's bad gamble to reach port via a dangerous shortcut and thus save \$30,000 in operating costs. And the *Argo Merchant's* watery death might never have occurred had her navigation instruments been in working order and her navigation charts up to date. ■

Cleanup and Prevention By Computers' Projection

Which way will an oil slick drift? Will it sink or float? Will it break into smaller slicks? What equipment should be rushed to the scene? Which coastal areas are vulnerable to leaks from offshore drilling?

Computers now are being widely used to answer these questions—in the form of highly accurate probability estimates which minimize spill damage, facilitating fast cleanup response. In some cases, they are helping to prevent spills by isolating potential trouble spots.

For example, computer models are being used by the government in leasing federal areas to private companies for the job of offshore oil drilling. By analyzing tides, winds, currents, and the chemical composition of oil, as well as the nature of targeted water and mainland, computers provide valuable data regarding where one should (or should not) drill. "Going even further than the drilling itself," notes Dr. Richard Smith, of the U.S. Geological Survey, "computer analysis is letting us know whether spills might occur in the course of producing and transporting the oil." The important thing, he added, is to insure that spills do not affect recreational areas—beaches, etc.—or adversely affect wildlife centers.

Two scientists at the Coast Guard Research and Development Base in Groton, Conn., have developed a computer model for oil spill cleanups.

Comm. Ivan Lissauer has developed such a model for the Delaware-New Jersey coast.

Preventive medicine in a sense, computer spill models may prove most useful in regions now void of oil activity altogether, but which may be developed in the future.

An extraordinary, dramatic glimpse of our biological cosmos... This 'natural history of the cell' probes at the very heart of our existence... the smallest of living things: **THE CENTER OF LIFE**

by L. L. Larison Cudmore

ALL cell biologists are condemned to suffer from an incurable secret sorrow: the size of the objects of their passion. Almost anyone with an obsession can share it with someone else. A numismatist easily lifts his gold, silver, or bronze inamorata from felt-lined mahogany drawers. Even an astronomer needs but a clear night to display his prized and flaming gems. But those of us enamored of the cell must resign ourselves to the perverse, lonely fascination of a human being for things invisible to the naked human eye. Never can we easily extend the invitation, "Let us go then, you and I..."

Some cells are extremely visible—the egg of an ostrich, of a hen or puffin. But we cell biologists see these the way anyone would, as a large globe of yellow yolk surrounded by a transparent glutinous mass; interesting only by virtue of their behavior in soufflé or omelet. We are happy to leave those particular cells to medieval painters or any others who love the transparency and staying power of egg tempera. For us a hen's egg is a delicious, marvelously packaged, but

essentially boring cell, with no resemblance to those miniature baroque houses we have visited, the ones so sterilely and forbiddingly dubbed "the basic unit of life." Our cells—the ones we love—are repositories of such fantastic architectural flights; pleasure domes beyond even the most opiated dream of Coleridge, a Xanadu percolating with the directed chaos of those hundreds of thousands of simultaneous chemical reactions that are life.

□ □ □

Every living thing is made of cells, and everything a living thing does is done by the cells that make it up. That is the truth and there are no exceptions; one reliable, unchanging fact in a changing world twenty-seven years after midcentury. These dictatorial cells have total control, even of our bodies, those of such a superior creature as *Homo sapiens sapiens* the wisest of the wise, a sentient, cognitive creature of supposedly independent will. Yet we don't make a move but that some group of the sixty thousand billion cells in our body makes its move first. Cells let us walk, talk, think, make love, and realize the bath water is getting cold. Cells that can translate light into electrical impulses let us see where the taps are; then we need more cells to turn on more hot water—nerve cells, muscle cells, and a biochemistry of which only cells are capable. ➤

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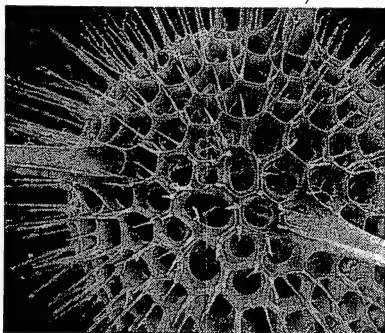
THE CENTER OF LIFE

Unbelievable, unsettling and sometimes unexplained things are going on inside our bodies. And the beginning of all of this is a single cell, a fertilized egg. Frantically swimming sperm meets lonely awaiting egg. They fuse. The egg gives a small, swift shiver, a slight electrical *frisson*. A wave of electrical charge sweeps over its surface. A tiny thunderbolt and *shazam!* a new organism begins. All that organism can ever be is no more than can be carried in this pinpoint-sized fragment of jelly. This is spectacular: the start of everything is simply this single cell splitting in half and then in half again. And again. One cell becomes two cells, then four cells, eight, and ultimately two thousand billion cells. No longer just cells, but a child with hair, fingernails, a heart, hair, and stomach. This isn't solved yet, how a single cell gets to be such a wonderful thing as a baby mammal. Nor do we know how from that mere cell beginning we get both red blood cells and nerve cells. Cells firmly believe that form should follow function, and one fertilized egg gives us the blood cell, a plump, thin-walled jelly donut of a cell, a sack of hemoglobin pushed around the body from lungs to heart and back again, and the flat star-shaped nerve cells, radiating as many as 60,000 electronic connectors.

They look different and they do different things: the red blood cells run their course, endlessly, delivering oxygen and taking away carbon dioxide, the waste product of life, to dump it in the lungs; the nerve cells are delicate transmitters and filters in a complex electronic circuit. But nerves and blood cells are only superficially different. Nerve cells, red blood cells, skin cells, or

sperm, like the colonel's lady and Judy O'Grady are sisters under all their differing skins. They share the same structures and the same chemistry.

It's not quite as simple as saying, "See one cell and you've seen them all." Actually you have to see *two* cells to have seen them all. The world is divided into haves and have-nots even in celldom. All living things are made up of either of just two kinds of cells: those that have a nucleus and those that haven't.



"... It has to be three lacelike fretted glass domes, one inside another like the ivory follies that are the pride of Oriental ivory carvers." (Magnified 950 times.)

Everyone—haves and have-nots—carries their hereditary information in DNA: two extremely long strands of it, wrapped around each other in a double helix. This is the repository of all of the knowledge a cell has; an encyclopedia and guide of what to do in all situations, possible and impossible; which molecules to make and use, which conditions to seek, which to avoid, how to move ... how to survive. All living things need their instruction manual (even nonliving things like viruses) and that is all they need, carried in one very small suitcase. If they needed

to, twenty-five furtive cells could hide under this period. The blueprints for the construction of one human being requires only a meter of DNA and one tiny cell. That's all. It's comforting to know that even Mozart started out this way.

□ □ □

Life has been going on for at least three and a half billion years, beginning as something very like a single prokaryotic cell. Since then it has been shaped and sculpted over and over, into roses and giraffes and fleas, but it seems that one general principle has always been followed. The evolution of cell societies parallels that of human societies: there has been a constant movement toward specialization of the members of the society. Increasingly, totally competent and independent individuals have become associated into complicated collections of specialized members. In the beginning, one member could do everything: make weapons, catch food, digest it, get rid of wastes, move around, build houses, engage in sexual activities straightforward or bizarre. Once they enter their societies, the members—whether cell or person—tend to become specialized, performing only one of the many tasks performed by the whole of which they are part (all of course retaining the right to reproduce).

□ □ □

With further evolution, we became more and more specialized; now an organism needs thousands or millions of cells to do all it has to do, and each cell has little independence. It can perform only one task and cannot survive outside of the total organism. Nor can it adapt to new tasks; a kidney cell can never—even in an emergency—take over as a heart cell or as a muscle cell. Sim-

Are Scientists Slow Learners?

Among scientists. If anywhere, we should expect new theories to get a fair hearing, for experimental science exists only to test ideas. Therefore, experimental scientists should be the segment of the population most receptive to ideas. The scientist, we are told, chooses what to believe in not by whim or personal prejudice, but by what is revealed through The Scientific Method, which reduces all personal bias to zero. *But all scientists are human, most are intellectually conservative, and most are usually wrong (and very slow learners in the bargain).* They were wrong about Copernicus's ideas. And Galileo's. And Pasteur's. And Mendel's. And Lister's. And Darwin's. And Goddard's. Yet the majority of scientists still haven't learned that the new ideas held by general consensus to be the most wrong usually turn out to be the most right. (I except the nuclear physicists; they seem to do all right by new ideas—after all, believing in a quark with charm and color deserves a lot of respect.) Biologists, on the average, are about thirty years behind their own field. I'm not asking that they love every new theory and clutch it warmly and wholeheartedly to their collective lab-coated bosom; I would be happy if they would just act like scientists. It is a bizarre paradox we are facing, for we find that experimental scientists (who are supposed to be fair) at times make the Spanish Inquisition a model of fair hearings and unbiased judgment.

ilarly, in human societies, although each of us stubbornly retains the right to do his or her own reproducing, we don't need to kill our food, make weapons, or get rid of our wastes. The local supermarket, the

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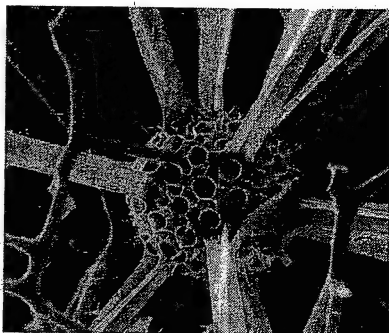
Pentagon, and the department of sanitation are there instead. Not too many of us could do all of the necessary things on our own. At one time we could. And at one time, about 600 million years ago, just a single cell could make weapons, catch food, digest it, get rid of wastes, move around, build houses, engage in sexual activity . . .

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WE are made of cells. And of stars. The universe outside of us has made the universe inside us. Those atoms created in fusion and fission at the beginning of it all went their ways and scattered themselves through the universe. Some ended up in that large molten ball careening through space in a complexity of spins—our planet earth circling on its own axis and around a star that makes its own spiral through a galaxy again whirling. In this Ptolemaic set of dizzying cycles and epicycles, protons became neutrons became electrons and then hydrogen and helium, then nitrogen, oxygen, and carbon; finally captured in the cooling mass a nascent life-supporting planet. Since atoms never die (well, hardly ever), those that were in at the creation—whether it was a big bang or just a smaller bang somewhere out in the suburbs of a constantly renewing steady-state universe—are still around. From the atoms that took up residence in a hot and gassy mass orbiting around a star of plus 4.8 magnitude, later cooling to become our home, from these atoms are we made and all things on the earth, those that crawl on the land, swim in the sea, and fly in the air, etc.

□ □ □

We know our genes don't change very rapidly. It is more than 30 million years since we bid genetic adieu to the hairy apelike ancestor we shared with the orangutan and the gorilla; and 15 million years has passed since we started off along our own peculiar evolutionary trail and left the chimpanzee to take its own turning. Yet in all that time and with all those apparent changes, our genes have themselves changed very little. Our genes are only one percent different from a chimpanzee's. All of the other sequences of DNA that make our genes we share with that amusing but disturbing ape, *Pan troglodytus*. The difference between a human being and a chimpanzee lies within that relatively meager portion of DNA that we don't share. We have exactly the same genes for hemoglobin as chimpanzees do, those molecules don't differ by so much as an amino acid, so our human hemoglobin genes cannot be more than a DNA



"At the center of the *Lychnosphaera regina*, one of the elegant amoeba architects. I have the suspicion that we're not the innovators we think we are, we're merely the repeaters. It took us an embarrassing three to five million years to develop the architecture the amoebas have had for a few billion."

base different from chimpanzee hemoglobin genes. We are two amino acids different from the gorilla in terms of hemoglobin, even though we left them behind at least 30 million years ago. Our blood types—A, B, O and AB—are shared with chimpanzees, orangutans and gibbons, but not with baboons or pig-tailed macaques, which should be comforting. (Gorillas all have type B blood.) So, only one percent of our genes seem to be uniquely our own. And of the remainder, that we share with our fellow primates, what percentage is uniquely ours as primates, picked up since we evolved from the tree-shrew, sharp of tooth and temper, who gave us all our thumbs and brains? How far back does our time machine go? What kind of traits would appear if we could turn on again these turned-off genes?

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... We might still have the genes to fly. Those reptilian archosaur genes that taught the vanished pterodactyl to fly and gave wings to the eminently successful birds. These archosaur genes may even have given flight information to our cousins, the bats. Will we end up flying? After all, flight seems to be the end point of evolution; most insect species fly, and those flying reptiles, the birds, fill our skies; among mammals, only rodents outnumber the flying bats. . . . It may be that we can turn our nuclear time machine on in the future and learn to fly; among the at least 800,000 unused genes we have, there may be flight. Birds and mammals came from the same reptilian ancestor somewhere along the way. Bats may have just renewed the flight capacity; they just turned on their archosaur genes that gave them light

bones, small size, and weird fingers. The Icarus myth that fascinates us so may really be in our genes, not just in the imagination of an ancient storyteller. Flight is beloved and envied by almost every human being, an integral part of our myths, dreams, and religions. Our flight fantasies could just be our old archosaur genes, repressed at the moment, but still nudging our unconscious, nibbling barely at our consciousness. □ □ □

Enzymes make things happen. Madison Avenue has promised us that so many products will do that: a toothpaste, a sleek shining automobile, a whiskey, a shampoo. But Madison Avenue does not love the truth, and often we follow their advice only to be disappointed. Enzymes will never disappoint us; they always deliver. They do make things happen, causing crucial reactions and interactions. Nothing at all can happen in our cells without the catalytic presence of one or more enzymes. Oh, those enzymes. Once upon a midnight dreary, a student of mine (then an art history major, now a goldsmith) burst into my laboratory, breathless from running the mile or so from his dormitory room. While pondering weak and weary over his Natural Sciences 5, he had experienced a true James Joyce "epiphany"; he had the transcendent realization that, toiling away from him, unknown, unloved, and unsung, were thousands—hundreds of thousands, even—of enzymes. He was truly transported. Not everyone can easily achieve such a nirvanic state of enzymic appreciation. We might try. We have nothing to lose. Establishing a mystical oneness with our enzymes would no doubt expand our consciousness immeasurably. And they don't ask for money. ➤

THE CENTER OF LIFE

Plants cannot do a lot of things. They cannot play tennis, go for a walk, or scratch themselves, but they do have the one absolutely spectacular trick never found in the animal repertoire: they can eat the sun. They transform the energy of sunlight into carbohydrates and thus get all of the energy they need or want. Free and forever. Not only are we made of stars, but we end up eating a star, too. Funny how things come 'round. Whenever we eat a plant (or an animal that has eaten a plant), we link up to a long, direct chain beginning in the sun and ending in some movement, mental or physical, that we make.

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There may be a masochistic streak in some scientists (or to be more kind the same streak, whatever it was, that drove men after questing beasts or Holy Grails), for it is a cold, hard fact that we will never find out for sure how the first cell arrived on the scene. Knowing that we can never know doesn't seem to stop them from trying to figure it all out, though they don't have a jellyfish's chance.

□ □ □

A cell always leaves the same first impression. It is incredibly crowded in there; a welter of structures crammed together like rush-hour riders in Tokyo or New York subways, with no apparent breathing space. But each of the structures is separate, partitioned off by a membrane boundary. And each has an exotic name worthy of a Russian countess or a Balkan intriguer, except for the nucleus. Despite its comparatively prosaic name, like the unassuming nanny who turns out to be the head of the espionage

A Will of Your Own?

We all have some idea of what our minds do. We've got a truly marvelous brain, where consciousness, associations and volition, and perhaps our "humanity" reside. IBM's best cannot touch those two "handfuls of porridge" under their bony arches for sheer complexity, computational talents, and information storage and retrieval. Not to mention the fingers, eyes, ears, and tongue that are electrically coordinated extensions of this mushlike computer. If it could build one, IBM would charge millions of dollars, but we get our brain free, courtesy of cells and evolution. Yes, we can trace consciousness and volition to the brain, but how much of that volition is subject to the cells that make up the brain? It's something to think about: whether we have a will of our own, or whether our will is that of the tiny collections of molecules and biochemistry, the cells.

network, the nucleus is the structural and actual center of the cell.

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Evolution is a hard, inescapable mistress. There is just no room for compassion or good sportsmanship. Too many organisms are born, so, quite simply, a lot of them are going to have to die because there isn't enough food and space to go around. You can be beautiful, fast, strong, but it might not matter. The only thing that does matter is whether you leave more children carrying your genes than the next person leaves. It's true whether you're a prince, a frog, or an American elm. Evolution is a future phenomenon. Are your genes going to be in the next generation? That is all that counts. ■

To Relieve the Laboratory's 'Fierce Tensions': Add

At 5, she read an encyclopedia from Aachen to zygote, having learned to read at 3.

At 9, her career in science was underway with an investigation of the death of a stray gopher.

In high school, she avoided physics and found biology a bore.

In college (UCLA), she began a pre-med course of study because it would be chic to be a doctor.

But in a sophomore class in genetics, Lorraine Lee Larison

"All the facts dressed up with a glittering style that cheers the reader as though it were sparkling wine."

— Isaac Asimov.

stumbled into a life's work as a molecular biologist. Researcher and professor (most recently at the University of Massachusetts, Boston), she has transmogrified into an author known as L. L. Larison Cudmore; excerpts from her first book, *The Center of Life*, are published on adjoining pages of this issue of Science Digest.

The book, written in six weeks "after I thought about it for a year," will be followed by a textbook in genetics "for the liberal-arts student who hates science." Previously, she has published in *American Scientist*, and was represented in the *Proceedings of the National Academy of Sciences* as a co-contributor as long ago as

1959, when she was still an undergraduate who had "happened" to solve a classic problem in protozoan genetics. (The model was *paramecium bursaria*, and the riddle was genetic control of four sexes (answer: by two different genes). Additionally, she found that some are homosexual.

That was the turning point; next came several years of graduate study, through the Ph.D., at Yale. There, she says now, women candidates first were weeded to the top 10 percent academically, and then "the most attractive" of the survivors were picked. Of herself, she suspects that her appearance has given her "a slight edge," and in any event, as her career developed, she feels "I got a gentler dealing with, because I am a woman." In academic laboratories, she believes, women can advance on the basis of good work to a degree "not necessarily true in the business world."

As a scientist, "I got confidence because I was nurtured by male scientists, fairly and gently." A female/male mix in a working situation is healthy, she considers, in terms of productivity. Male scientists, she thinks, tend to like to have women working beside them, in that the "fierce tension" of a laboratory is lessened, and a "more rounded viewpoint" is possible because women offer "a different approach" to many problems. ➔

Lorraine Cudmore suggests that hormonal makeup is a root cause of variations in drive and energy that differentiate the sexes: "To produce the same amount of energy as a man, a woman must drive herself more."

The impression that most people retain of science from childhood reading matter, in her opinion, is that it requires aggressiveness and competitiveness. And women are not encouraged in competitive qualities, and "tend to shy away from winning." Science, she found, lacks role models for women to follow, but her own career decision was made "after I saw how much fun it is."

From the book, recounting "a sad memory" from a summer symposium:

"There . . . I first realized the cheerless, sterile fate of many a woman scientist. I roomed for one night with another female biologist, a few years older but similarly unmarried. Apropos of nothing, this woman began to bewail her single state, and with saddest mirth I have ever heard, she quoted one of her colleagues who had assured her, quite cruelly, that women scientists were like the cells of a multicellular organism: once they had specialized, they did not reproduce. . . ."

Though Lorraine Larison since has married and become Mrs. Cudmore (wife of an inventor), she recognizes a tendency for women scientists not to marry, or, being married, to divorce. The cause, she believes, probably is that "You get surer of yourself, you get very picky, you can support yourself, you have your own ideas, and you're not so easily satisfied." And, married, women scientists



L. L. Larison Cudmore: "We are basically the prisoners of our cells, and I find it pleasingly paradoxical (if somewhat demeaning) to be in the thrall of something that small and mindless. We can be more than our cells together are . . ."

tend to be childless or, having children, to have a focus in which children are not "the center of life." (The coincidence of phrasing appears to be unintended.)

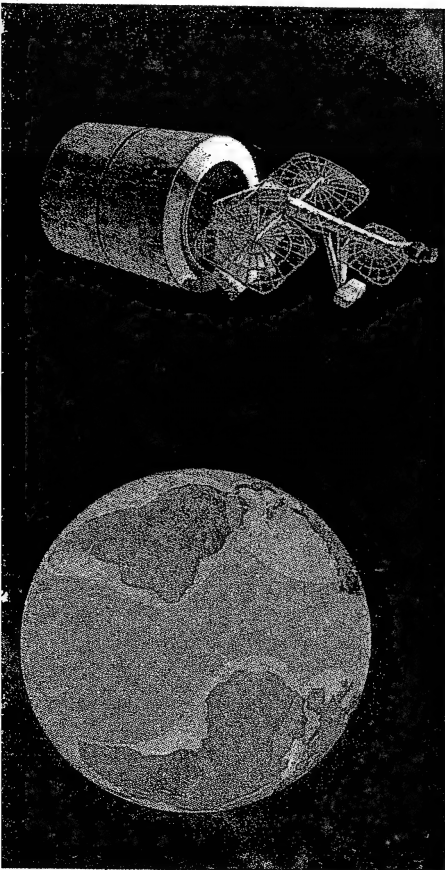
Of her own writing, whether in 65,000 words on the cell or in a genetics text, "I happen to like my style," which she accurately regards as distinguished by a "literary playfulness." With Venus 2H pencils, she attacks yellow legal pads enthusiastically, then on the succeeding afternoon types up the result. As a variation on the theme, she finds this almost as rewarding as she found "the epitome of molecular biology research," where "you never see what you're working with, and never see the results except through a computer."

"When you publish," she reflects, "it doesn't matter what you look like."

Communications Satellites: How Your Voice (or TV Show) Is Routed Geosynchronously

by J. Kelly Beatty

An artist's concept of Intelsat IV.



Imagine for a moment that you have just picked up the telephone to call a friend living in England. After dialing the number, you wait a few seconds and perhaps hear a distant click or two before his phone starts ringing. He says "Hello," and after a few minutes' conversation, you exchange goodbyes and hang up.

Neither of you may realize it, but your call probably has been routed through a sophisticated communications satellite circling high above the earth.

Usually called *Comsats*, these electronic switchboards-in-the-sky are being used increasingly to relay long-distance telephone, television, and other transmissions around the world. ("Comsat" is a registered trademark of the Communications Satellite Corp.; it is not a generic term or acronym meaning ("communications satellite.") Comsats were employed in two of every three transatlantic telephone calls last year, and they constituted 13 of the 19 payloads launched by NASA.

To understand the explosive surge of space-linked telecommunications, merely look at the cost advantages of satellites over conventional transmission methods: At present six undersea cables link North America and Europe. The most recent of these cost \$191 million and can accommodate about 4000 telephone circuits. Yet a modern Comsat costs roughly \$50 million (half of which pays for the launching), and it can often handle more than one and one-half times as many calls.

A new generation of spacecraft, now being tested, can transmit tv

Adapted, with permission, from an article in Sky and Telescope, July 1977. Copyright © Sky Publishing Corp., 1977.

SATELLITES

programs directly to small portable antennas, an advantage particularly useful in remote areas where outside contact is infrequent.

Echo I, launched in 1960, was the first true communications satellite, and a second, larger Echo was orbited in 1964. Their reflective surfaces allowed powerful microwave signals to be bounced back and forth between ground stations. Satellites of the Echo type are called *passive repeaters*, because they do not amplify the signal but merely reflect it. Their effectiveness is limited by large size and the impractically powerful equipment required to send and receive messages.

The true value of communication satellites was tested in 1962, when Telstar 1 was placed in orbit for Bell Telephone. Telstar was an *active repeater*, amplifying and retransmitting as many as 60 two-way conversations at one time.

But this technology still was limited by low-altitude orbits, which put the spacecraft within view of ground stations for only short periods of time. The problem was solved by a scheme first suggested by Arthur C. Clarke in the October, 1945, issue of *Wireless World*:

"It will be observed that one orbit, with a radius of 42,000 km., has a period of exactly 24 hours. A body in such an orbit, if its plane coincided with that of the earth's equator, would revolve with the earth and would thus be stationary above the same spot on the planet. It would remain fixed in the sky of a whole hemisphere and unlike all other heavenly bodies would neither rise nor set. . . .

"Let us now suppose that a station were built in this orbit. It could be provided with receivers and

transmitting equipment . . . and could act as a repeater to relay transmissions between any two points on the hemisphere beneath, using any frequency which will penetrate the ionosphere."

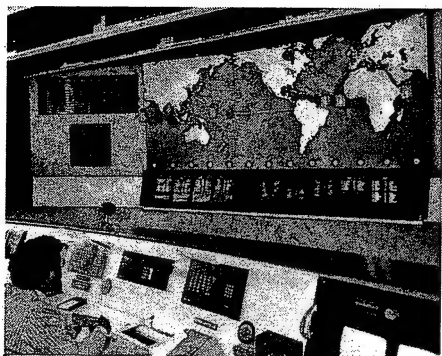
Prophetically, Clarke had described the use of *geosynchronous orbits* for communications spacecraft. Eighteen years later, Syncom 2 became the first satellite to operate from such an orbit. Geosynchronous satellites are now the industry standard.

By the mid-1960's, solar-cell and micro-circuit technology had advanced enough to allow commercial interests to develop their own spacecraft. From time to time, however, NASA has tested experimental hardware that corporate users were unwilling to place in operating systems. Most of these tests have been conducted aboard NASA's Applications Technology Satellites (ATS). The first was launched in 1967.

The Soviet government now is developing a new class of geosynchronous satellites called Stationars, with more powerful electronics and a three-axis stabilization system. Perhaps a dozen of these advanced spacecraft will operate through 1990. Dozens of general- and special-purpose satellites have been developed or purchased by other groups.

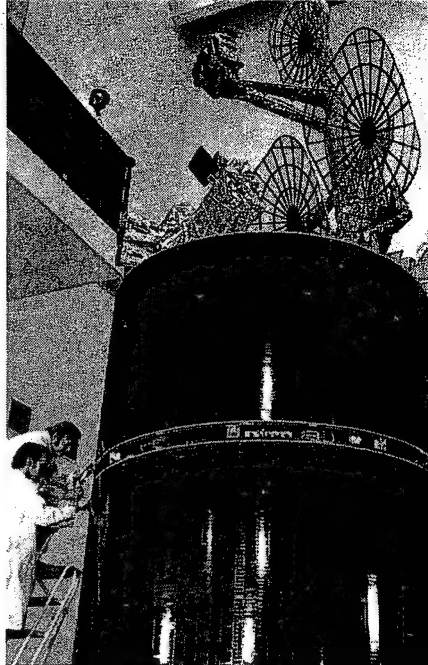
Communications satellites vary widely in size, capacity, and purpose, so description of a "typical" operation must be generalized. One versatile spacecraft is the Intelsat IVA, whose basic design has been adapted to a number of other satellites. (One version, called Comstar, can handle 14,000 calls at once!)

Once in its prescribed position over the earth, the spacecraft is ready to go to work. Since a geo-



Operations Center where the entire global system is constantly monitored.

Intelsat IV-A is readied for service.



synchronous satellite always appears to be in the same location, a ground-station antenna need only be pointed once. These stations are owned by the International Telecommunications Satellite Consortium (Intelsat) member nations. (Intelsat is by far the most extensive satellite system, with 95 member nations operating 120 ground stations worldwide.) Messages usually are beamed up to the satellite at one frequency and received at another. The "Comsat" makes this frequency conversion using an amplifying device called a transponder. This allows a single ground antenna to send and receive signals at the same time. A new beam-separation technique now allows the *same* frequency to be used by two different pairs of ground stations simultaneously.

About 80 percent of the satellite's capability is used for telephone service; another 18 percent is taken up by coded messages and other data;

and—surprisingly—television accounts for only 2 percent of the transmissions.

Just how much space around the earth is left for all this orbiting hardware? There is growing concern, and a five-week conference on telecommunications practices was held earlier this year in Geneva. One result was a plan for the global distribution of present and future equipment in geosynchronous orbit. Eventually, the Space Shuttle may bring back outdated satellites.

The airwaves are getting crowded, too. By the early part of the next decade, communication satellites will relay some 70,000 conversations at any given time. To relieve the congestion, future satellites probably will alter the traditional transmission frequencies to allow a higher information density in each carrier signal.

As the need for global communi-
(Continued on Page 82)



**SCI/DI
BOOK BONUS**

In total ignorance of their real traits, humans have attributed to many animals a variety of human traits in the ideal or extreme. Lions are noble. Wolves are ruthless and savage. Peacocks are vain. Hyenas are slinking cowards. Songbirds are cheerful. Eagles are proud and watchful.

The list of anthropomorphized animals is long and venerable. Many of the traditional traits were already well established in Aesop's day some twenty-five hundred years ago.

Broadly speaking, one may categorize the popular attitudes toward animals as a kind of moral classification holding that animals are either good or bad, heroes or villains. This distinction, which has often been held even by the people charged with ensuring the conservation of wildlife, stands in the way of a mature and sensible attitude toward wildlife. It is usually difficult to throw out old ideas, particularly

ones that have been held for a long time, when new ones come along unless we can examine the reasons for the origin and persistence of the old ideas.

The origins of man's relationship with the beasts must have begun perhaps three to five million years ago, when man was just starting out. Our earliest attitudes toward wild animals were probably neutrality or mild curiosity toward herbivores and deathly fear of carnivores. Keep in mind that these were not merely academic positions regarding animals but emotions that were lived with every day and upon which survival often depended. In fact, a fear of carnivores may well have shaped early man's intelligence. Lacking fangs or claws and without even the other herbivores' speed, intelligence undoubtedly helped man to avoid or escape predators. Duller members of our ancestral families fell prey while the smarter ones lived

The time has come to put away our animal myths and immature conception... and realize implications of

THE CULT OF THE WILD

by Boyce Rensberger

to pass on the genes for their superior mentality to their descendants.

Reformed Vegetarians

But things changed. For some reason, which remains unclear, man's ancestors did not remain herbivores. They took to eating meat as well, and that inaugurated the first of three great revolutions or transformations in relations between man and the other animals. The taste for meat may have developed when opportunistic vegetarians sampled a dead carcass, perhaps an abandoned lion or hyena kill. Those who had the teeth for it and digestive systems that could handle animal protein thrived. Their improved nutrition made them stronger. The risk of mental retardation due to protein deficiency in a drought was reduced because long after the plants dried up, prey would survive, however weakened. And

the big brain accelerated on its course toward us. Relations with other animals would never be the same again.

Early man's attitudes toward the carnivores probably remained much as they had been, but there may have been the beginning of an admiration or a respect for carnivores' hunting abilities. Observation of a pride of lions working cooperatively to make a kill, for example, may have given early man a lesson in improved hunting techniques. Man's views of the herbivores, however, must have changed dramatically, as did herbivores' views of man. They were now quarry and they learned to fear man.

This state of affairs lasted from the beginning of early man's appearance three to five million years ago and probably did not begin to change significantly until about fifteen or twenty thousand years ago with the beginning of agriculture. Man's most deeply ingrained attitudes toward animals, then, are those of hunters—not sport hunters but people who had to hunt to live. Though they were close to nature, our hunting ancestors were actually not in as close contact with animals as we might think. They avoided predators for obvious reasons, and herbivores, for equally obvious reasons, avoided man. Although they obviously came to know the comings and goings of various animals—enough to avoid some and find others—the rest of their animal lore was probably based as much on fantasy and superstition as on fact.

Big Game Fixation

There is archaeological evidence in Africa, Europe, Asia, and North

CULT OF THE WILD

America that as big game hunters, as this way of life is known among anthropologists, entered virgin territory, they killed as many animals as they could. The fossil records in these areas reveal abrupt extinctions of many big mammal species at about the times the hunters arrived. The most amply documented evidence of this comes from North America, where efficient big game hunting did not appear, according to the most widely held expert opinions, until about thirteen thousand years ago.

Paul S. Martin, a University of Arizona anthropologist, has examined the fossil remains in North America of such giant mammals as the mastodon, mammoth, and giant ground sloth and found that all became extinct at about that time. He has offered evidence that a wave of extinction radiated from the region of Alaska southward and eastward through North America. Although man was in the Western Hemisphere long before this time, the evidence suggests he had depended on a broad spectrum of plant and animal resources and lacked hunting weapons and skills to kill the larger mammals in significant numbers. Around thirteen thousand years ago, however, either a new set of weapons was developed or a new wave of human migration across the then-exposed Bering land bridge brought a new way of life to North America. The people of those times were identical to ourselves and possessed as much intelligence as we do. In a rel-

The big game hunter's principal legacy, aside from rows of dusty, disembodied heads and the depletion of many species all over the world, is another contribution to the alienation of urbanized people from wild animals. Their tales have added to the illusion that the wilderness is a dangerous place where only the brave go and then usually accompanied by a retinue of gun bearers. This belief is still surprisingly strong in urban peoples today who find it a bit scary to spend a night in the woods. Can it be that we still retain the primal fear that all the good animals are asleep at night and that only bad ones are active then?

atively brief period, Martin argues, this new tradition of almost exclusive subsistence by big game hunting exterminated nearly all the largest mammals.

Behind the advancing front of big game hunters, however, some people remained, to prey on the smaller animals. After the first rampage of slaughter, they changed their hunting ways of necessity to a more measured pace that would allow a certain portion of animals to survive. Smaller animals are more numerous than big ones to begin with, but still, wholesale slaughter could not be allowed to continue if there were to be any animals left to reproduce for the following year's harvest.

Quite likely this same pattern of massive overkill followed by sustained-yield hunting took place all over the world, wherever man went and whenever a new hunting tool—say, a sharper spear point or the newly invented bow and arrow—increased man's hunting efficiency.

As unbridled hunting became increasingly improvident around the

Boyce Rensberger is a science writer for The New York Times. Excerpted with permission; published by Anchor Press/Doubleday. Copyright © 1977 by Boyce Rensberger.

world, early man had to tame his initial tendencies and increase his efficiency. One problem with killing a large animal is that most of the meal spoils before it can be eaten. Even a relatively small carcass—for example, that of a deer—provides more meat than the typical hunter's family can eat before it goes bad. Thus it may well have been that those hunters clever enough to devise preservation and storage methods, such as drying or salting or burial in cool earth, had more protein over a sustained period of time than did their duller cousins. Again, intelligence and an ability to plan ahead would prevail.

As the abilities of early man grew, he came to look at the animals of the forests and plains not only as food on the hoof but also as living beings something like himself. Animals, he could see, were often anatomically organized much like people—eyes, nose, mouth, and ears positioned roughly the same way on a head attached by a neck to a trunk with four limbs. Like people, some animals hunted their food while others foraged it. They sometimes lived in families, mothers suckling the young. Usually families were peaceable, but sometimes there were quarrels. When danger threatened, the bigger ones usually defended the smaller ones. In other words, there were enough obvious similarities between man and the animals that it no doubt was as easy then as it is now to project some distinctly human, or anthropomorphic, traits onto animals. Slow and awkward appearing animals must be stupid; fleet and agile creatures must be quick-witted. Nocturnal animals must be evil and up to no good, while those that are abroad in daylight must be pure and open.

How, then, our ancestors may have wondered, did the animals regard people who went about killing animals much of the time? Projecting human values, our ancestors may have reasoned that the animals would respond the way people do when members of their clan are killed.

Objects of Veneration

If hunters slew an elephant, might the beast's surviving kin not come to seek revenge? Or if they killed a wildebeest, prize quarry of the lion,

The molecular structure of human proteins shows them to be almost totally (more than 99 percent) identical to the comparable proteins of chimpanzees. Since each change in a protein is the product of a corresponding mutation in the chromosomes, this means there have been very few mutations to account for the evolutionary distance between man and ape. There are fewer mutations standing between us and chimpanzees, for example, than there are between chimpanzees and monkeys. Molecular biology, then, suggests that we are, at least in our internal chemistry, still very much animals. We are a very distinctive species, of course, but animals nonetheless.

might the lions not try to punish the men for raiding their herds? Somehow, our ancestors may have reasoned, ways must be found to placate or appease the offended animals. Since man needed meat to survive (vegetables in a preagricultural society rarely would have provided adequate nutrition), some kind of compromise must have been worked out to balance man's fear of revenge.

One method must have been to make animals objects of veneration

CULT OF THE WILD

and homage. Idolize and idealize animals, our ancestors must have thought, and that will atone for the sin of killing animals. Thus we have, in the oldest known works of man not made for a practical purpose, images of animals in all their magnificence. In the cave of Lascaux in France and in many others around Europe and on rock faces in North and East Africa are frescoes and incised drawings of extraordinary beauty and style. There are animals with great swooping horns, running animals, mating animals, slain animals, magnificent animals, fearsome animals. In one scene at Lascaux is a herd of horses within a frame of deer heads, together with cows, bulls, bears, lions, a rhinoceros, and a buffalo which has just killed a man with a bird's head.

Although the real meaning and purpose of cave art has long been controversial, little doubt remains that it was meant to serve some magical or religious purpose. Many of the scenes are in remote and cramped parts of caves where no one but the artist would be likely to go. When the artist had paid his

tribute, the only witness to his devotion would be Mother Earth herself. Veneration of animals has, of course, been a staple of human cultures ever since.

Crops Redefine the Enemy

Whatever attitudes toward animals we may have brought with us from our hunting past, they are not the only ones we now have. For at some time in the past—it varies from place to place—hunting began rapidly to fade as mankind's chief means of livelihood. Agriculture replaced it and man's attitudes toward wild animals underwent the second major transformation. Wild animals of all kinds became man's direct enemies.

The crops and domesticated animals that farmers kept were constantly threatened by predators and herbivores. The lion, always a threat to people, now also became a menace to the flocks of sheep and herds of goats kept by early pastoralists. The wolf, never much of a threat to man despite popular impressions and, in fact, from whose amiable ranks the dog was domesticated, now became hated for its pre-



dation upon the tame herds. More dramatically, those smaller plant-eating animals that had not been major food sources for people and to which people were largely indifferent, became man's enemies when they chose to forage among the crops. Even the birds and insects now became enemies because of their attacks on crops. In short, for the bountifulness of agriculture, which enabled human populations to surge in numbers and to establish settled, civilized villages, man had to declare war on wildlife—all wildlife; the only good animals at that time were the domesticated ones.

'Impoverished' View of Nature

The third great transformation in man's views toward animals came as villages grew into cities, where large numbers of people, particularly among the educated (privileged) classes, had almost no real contact with wild animals and no genuine stimulus to think of a given species, if at all, as a friend or an enemy. Consequently, the way was open to invest any animal species with any supposed attribute, regardless of how well it fit reality.

The long process of alienation of Western and industrialized man from wildlife has today gone about as far as it can. The assortment of opinions about any unfamiliar species would seem to be essentially random. Generations of fables, confining zoos, and fading instincts have put us at such a distance from the beasts that, in our efforts to recapture an elusive sense of "oneness with nature" we assume that that state must be some kind of utopian paradise—clean, pristine, unspoiled. We have lost touch with so many animals that we are unable to have a realistic concept of nature.

It is the measure of our alienation from wildlife that we conceive of it as something apart from ourselves. The most pathetic aspect of this alienation is that when we do try to appreciate wildlife, we do it with the blinders of centuries of myth and misunderstanding.

We marvel over the photographed wild flowers in the nature magazine and ignore the insects prowling in our hedge. We stare at the sleepy lion in the zoo and strug-

If we are to have wild animals living on earth with us—truly wild and free-living beasts—then the time has come to put away childlike ideas about what animals are. There never was a Bambi or a Big Bad Wolf. Lions are not noble, brave, clean, thrifty, or reverent. The world would not be a better place without sharks or hyenas, or even without cockroaches or termites. Such notions about animals should disqualify a person from having any role in making the hard decisions that must be made in realistic and rational wildlife conservation programs.

gle to make it match an image of regal serenity. We watch a white-tailed deer bound across the road and think of Bambi.

It is time to put away this impoverished, alienated view of nature. It is time to recognize that man is also a part of nature and that there really never was any such thing as a constant or untouched wilderness. The glory of the natural world is not that everything was created just so. It is that the earth has always seen shifting natural panoramas, with one species rising up, spreading out, and changing the face of the earth while others recede and even die out. It is a drama that is constantly unfolding, and however much we think we deserve only to be in the audience, we are on the stage. ■

What dog ranks in the top 40 percent of all breeds in popularity . . . but is best known for inaccurately fictionalized traits and feats?

What dog has a nose that reputedly is two million times more sensitive than yours?

What dog uses his ears to help improve the nose's sensitivity in a pinch?

What dog is a single-track-minded loner while working, but is a gentle sentimentalist in his big heart—and often kisses his quarry?

The answer, of course, is the

BLOODHOUND

...an almost mystical breed, destined for moments of truth, years of semi-anonymity and movie-style pseudo-heroics.

by Roger Caras

True, he's 55th in popularity among all the 135 breeds and varieties that the American Kennel Club recognizes, but fiction rather than fact seems his fate . . . perhaps, in part, because he's cursed with that chilling name.

Where *did* the bloodhound earn its name? The truth is, actually, something of a crown of distinction. First, know that the name has nothing to do with the dog's habits, for it is one of the gentlest of all breeds; nor does it follow blood-spoor. Rather, the origin lies in traditional British class-consciousness. In the Middle Ages, two basic hounds were

in use in England. One was owned by commoners. The second was so superior that its ownership was restricted to persons related to or associated with the royal family. It was called *the hound of the blood*, or the blooded hound. And, obviously, it has come down to us in a shortened version. The breed actually dates back about 25 centuries to ancient Rome; at least, similar ancestors were known then.

Encountering your first bloodhound, you may be surprised by its size. Somehow, we tend to think of this storied breed as a slightly leggy basset or a long-eared beagle. Actually, last year's bloodhound winner in Madison Square Garden, Ch. The Rectory's Limbo, weighed in recently at 152 pounds. (My son's bloodhound, Ch. The Rectory's

Mr. Caras is a network correspondent for ABC. His radio program, "Pets and Wildlife," can be heard on CBS-Radio.



Author Roger Caras with two of his bloodhounds: The Rectory's Peter's Pence (left) and her father, Ch. The Rectory's Yankee Patriot.

Yankee Patriot, though not yet mature, weighs over 130.) So they are big dogs, large enough that they rank among the giant breeds.

To put other myth, legend, and nonsense aside, let's look at what has become the Hollywood version of the allegedly bloodthirsty bloodhound. And it all can be discredited. Here are the facts:

1. Bloodhounds never are used to attack: They follow a trail and they don't care whether it's that of an elderly person who has wandered from a geriatric home, a child missing from a picnic, or an assassin. All the hound knows is that he (or she—bitches frequently are the better trailers) has a trail to follow. When the quarry has been tracked down, he often receives a kiss from the hound, who then expects a reward from the handler.

2. Bloodhounds trail silently: They do not race howling through the woods at night as in Grade B movies. No police officer wants to come upon a suspect while sounding something like a circus train. Unannounced is better when the other fellow may have a gun.

3. Bloodhounds do not trail in packs: Almost always they are used alone, rarely in pairs—but never in the movies' fictional herds.

4. The bloodhound never is allowed to run free on a trail: The simple reason is that the handler would never see his dog again. A trail may be dozens of miles long (the record run is 138 miles) and, without a lead, a handler could not keep up. The bloodhound is trailed silently, singly, on a lead. Another factor: he characteristically has no road sense. If something smells good, he

One Scent Among 55,000

I once helped the New York City police run tests in Central Park with a State Police bloodhound. They wanted to see if the dog could be used in the city environment. Following a trail laid down by a detective, the hound ran right through four softball games and across an area known as the Sheep Meadow. The evening before, 55,000 had attended a rock concert in that field. The dog was able to sort out that one trail out of the lingering 55,000 scents, and stay with it. —R.C.

BLOODHOUNDS

drops his nose and goes. He will cross any street without a pause.

Does the bloodhound follow footprints? Only in poorly written detective fiction. When a person moves, and especially when he (or she) runs, body and clothing together act like bellows. Particles of scent are pumped out from the crotch and armpits, and to a lesser extent, from the rest of the body. These invisible particles are the trail, and the bloodhound's enormous nose (it is regarded as two million times as sensitive as a human's) gathers them in. On warm days, the scent particles may rise and the dog then would need to jump to catch them midair. When that happens, an experienced handler settles down and waits for sundown and cooler air.

But on a cold, damp day, scent particles may settle on the ground and then the hound uses his ears! He moves his head from side to side and his ears, which hang below his nose, swirl the particles around so the nose can catch them. If a strong wind bends the trail by moving aside scent particles, the hound follows until the proper trail resumes.

If you're a criminal, and you try to dodge a trailing hound by wading across a stream or along its waters, the dog can still follow—doggedly. Scent particles hover over water as easily as over land. After his prison break last summer, James Earl Ray tried the watercourse tricks and failed to lose the hounds.

A trail need not be fresh, although freshness reduces the margin for error. Not long ago, Quincy, a trailing bloodhound owned by a Long Island policeman, Sgt. Jim Zarifis, picked up the trail of a suspect almost 20 hours after the man had fled the scene of his crime.

The Baby-Sitting Role

Bloodhounds are gentle animals, even tender, and are just great with children. Their somber looks make them a delight to have around, and they have a stoic quality that makes them good baby-sitters. They are not fighters and are good with all other animals once they get to know them. They need an enormous amount of exercise to keep in condition. For that reason, they are not good apartment dogs, but belong in a very active, physical environment, perfect on the farm, or out in the country.

The colors are limited: black and tan, red and tan, or a kind of tawny. The coat is thin and loose. The dog may stand to 27 inches at the withers and weigh as much as 110 pounds. Either sex is a fine pet animal in the right setting. Never buy a bloodhound from a pet dealer; only from a breeder. Pride in this breed by people who have devoted their lives to it is immense. They don't want their dogs in the hands of people who won't share that pride and match it with love and care. No breeder of bloodhounds wants to think of one of his puppies misused or ill-cared for.

—From *The Roger Caras Pet Book*
(Holt, Rinehart and Winston,
1976, \$7.95)

Quincy followed him to his home over ground that was still wet after several days of rain. (That record run of 138 miles was on a trail 104 hours—more than four days—old.) Nonetheless, a fresh trail is best.

Face-to-face with a bloodhound, you will be amazed by the loose skin. Those wrinkles are just a sample; he's like that all over his body. Again, a simple reason explains why he has been bred that way: On the trail, he will not stop for anything. Caught in a barbed-wire fence or a briar patch, he can work loose and

continue on, when a tight-skinned dog would become hopelessly hung up. A bloodhound is as accomplished as a cat in wriggling free from a natural hazard.

Because they are so extremely good natured, bloodhounds are sometimes erroneously regarded as pets. But they are pets for only the most experienced and devoted dog-people. They are far too much trouble for the casual owner, especially a first-time owner. They need an absolutely enormous amount of exercise; have special feeding requirements because they are susceptible to a potentially fatal condition known as gastric torsion; and demand both room and attention.

Tracking the Quarry

The ultimate object of any hunt in the wilderness is the bloodhound. (In the search for James Earl Ray), Sammy Joe Chapman, chief supervisor of the Brushy Mountain prison kennels, had only two fully trained hounds available for the forest searches . . . Consequently, the FBI brought in its own pack of bloodhounds. But when the feds gave their dogs some convicts' garments to sniff, just like in the movies, locals scoffed. "Pure Hollywood," said one. Chapman put his dogs in pursuit by taking them to a single fresh track that gave them the scent they followed through the woods.

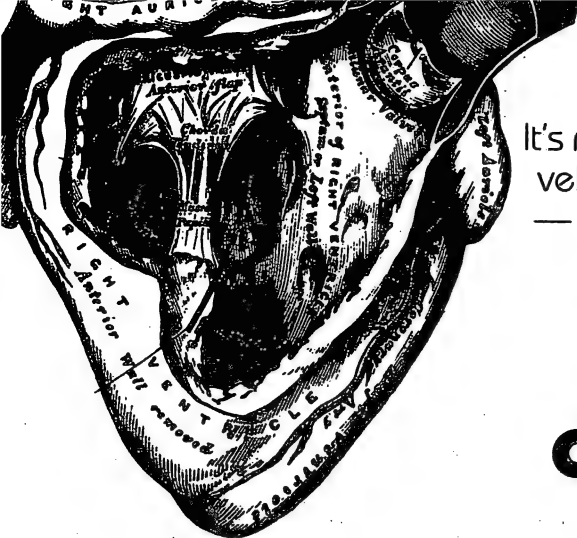
Prisoners resort to all sorts of stratagems to throw a dog off the trail. Some escapees have sprinkled pepper on their shoes or changed clothes—to no avail . . . Surprisingly, a runaway's best defense is dry weather, which can often blend all local smells together, making them indistinguishable to a hound.

—TIME Magazine

With unbelievably powerful hind-quarters, they tend to pull on a lead. A saying suggests humorously that you can identify a bloodhound's owner because one arm is two inches longer. (I write as the owner of two bloodhounds, incidentally.) They are also expensive, and a good example of the breed costs \$500 to \$600 as a puppy, and much more when grown. They truly are special dogs for special dog-people.

What about the bloodhound and the law? Under certain conditions, his "testimony" may be as good as yours or any other human's in a courtroom. That is, if he arrives in court with a AKC registration showing the pure-bred line, plus a certificate attesting that he had had trail training (by the Police Bloodhound Association or an equivalent) his "evidence" can be accepted. For example, if he has been allowed to sniff the seat of a car used in a crime, and then followed a trail and located a person, in effect "telling" the handler that here's the quarry—that is legal testimony about as good as that of an eyewitness. One famous trailing dog, Nick Catter by name, contributed to the arrest and conviction of almost 600 criminals.

We live in a world of electronic marvels and incredible speeds. Man still has not devised a means, however, as sure and reliable as the bloodhound in locating lost children, straying mental patients, and escaped criminals. No matter where they go, how fast they run, what they clamber over or through, this ancient giant dog with his incredibly sensitive nose will be able to recreate those movements for his handler. All he expects in return is a lot of TLC. The sharpest bad-guy chaser around, he is also the biggest sentimental slob in town. ■



It's never too early to develop a healthy lifestyle — but 4 of 10 teenagers already show heart-disease risk factors

YOUNG at HEART

by Jim Powell

Seven million of us under 45 have heart disease.

The estimate is from the Center for Health Statistics.

No longer can heart disease be considered a problem of age.

The warning is by Dr. Edward Kass of the Harvard Medical School.

A study shows that 40 percent of teenagers have at least one "risk factor" for heart disease. (Risk factors include smoking, overweight, high blood pressure, and excessive cholesterol.)

The authority for that figure is the American Health Foundation, screening 3000 young people in its Know Your Body program.

"Clearly, the most effective way to save lives is to prevent that first heart attack. Long-established habits are notoriously hard to change. We must do everything we can to develop healthy habits among children."

That message is from the foundation's president, Dr. Ernst Wynder.



With four of every ten teenagers exhibiting a "risk factor," identifying those at risk, then eliminating

the risk, is the best way to protect them from heart attack in their 30s, 40s, and 50s. A consensus of spe-

cialists in the field shows these as the six most important ways to help prevent early heart attack.

1. Stop smoking. A man or woman who smokes more than a pack of cigarettes a day has nearly double the risk of heart attack and five times the risk of stroke than a non-smoker.

Nicotine in cigarette smoke stimulates the flow of adrenalin. This, in turn, makes the heart beat up to 20 times more per minute, increasing its need for oxygen. But the carbon monoxide in cigarette smoke displaces oxygen in the blood. As a further insult, nicotine constricts the arteries, increasing blood pressure 10 to 20 points. The heart must pump against higher resistance, so every puff strains the heart.

Nicotine also triggers the release of fatty acids into the blood. Somehow, platelets, which figure in clotting, become more sticky. The action of fatty acids and platelets increases the risk that clots will form and block an artery—thus leading to heart failure or stroke.

When teenagers smoke, they start this deadly process early. Consequently, they will be among the first of their peers to die. But stop smoking, and risk falls to half that of people who continue smoking.

2. Keep blood pressure low. Heart attacks strike three to five times more people with high blood pressure than people with normal blood pressure. The stroke rate is seven times higher.

Your circulatory system can withstand the brief high pressure involved when your heart is pumping. But sustained high pressure means more wear and tear on your arteries. This leads to the formation of scar tissue, which is less flexible than healthy tissue; scar tissue appears to

play a key role in hardening the arteries. Cholesterol tends to deposit where there's arterial damage.

Partial blockage of blood vessels feeding the heart reduces its ability to handle stress. Exertion can bring on the agonizing pain of angina. As blockage progresses, the heart has difficulty even when a patient is at rest, and the pain becomes more common. This may be a prelude to heart attack.

Though many drugs are available for controlling high blood pressure, doctors hesitate to put young people on drugs. Using them for several decades increases the chance of developing side-effects like diarrhea, impotence, depression, diabetes.

So diet remains the preferable treatment. Says Dr. Jeremiah Stamler of Northwestern University Medical School: "On the average, an American consumes about a third of an ounce of salt each day. Conceivably, by cutting this in half and shedding excess pounds, mild high blood pressure may be controlled without drugs."

Dr. William Kannel who heads the longest continuing study of heart disease, offers this assurance: "Control of high blood pressure definitely delays congestive failure, prevents strokes and prolongs lives."

3. Maintain lean body weight. Our circulatory system is a gigantic network 60,000 miles long. Each pound of fat requires another mile of capillaries to carry essential nutrients. This means more blood. Overweight doubles the chances of developing high blood pressure.

Overworked, the heart enlarges. But the blood supply to the heart doesn't. So the heart may suffer from a critical oxygen shortage. When that happens, a patient experiences angina. ➤

YOUNG at HEART

Overweight children tend to become overweight adults. So "baby fat" isn't to be pooh-poohed. The sooner it comes off, the better.

4. Eat a low fat diet. The chances of heart attack triple as cholesterol goes from 150 to 250 milligrams per 100 milliliters of serum. Yet not everyone with a high cholesterol level will get heart disease.

Cholesterol by itself isn't a villain. On the contrary, this waxy alcohol is essential for your body to make healthy cell walls and certain hormones. Even if you didn't eat any cholesterol, your liver would still produce it.

It's carried through the bloodstream by substance called lipoproteins. Three kinds figure in heart disease. Very low density lipoproteins (VLDLs) carry fatty compounds, which appear when the diet

contains too many carbohydrates and calories, from the liver to various sites through the body. When VLDLs deposit their load, they're converted to low density lipoproteins (LDLs). These carry cholesterol from the liver to various sites. High density lipoproteins (HDLs) clear away unneeded cholesterol and bring it back to the liver.

A diet with a lot of saturated fat stimulates the liver to make VLDLs and LDLs which spread heart disease. So it's prudent to minimize intake of saturated fats.

Polyunsaturated fats stimulate the production of HDLs which protect against heart disease. These come from vegetable sources like corn, soybeans, sunflower seeds and safflower seeds.

Total fat intake should be cut down. Fat has twice as many cal-

Example ... at Home and School ... Is First Step

Schools offer an opportunity to help children develop healthy habits. The American Health Foundation's Know Your Body program starts with screening. Then students—who volunteer with their parents' consent—record their test results in a personal "Health Passport." Teachers explain how smoking, weight, cholesterol, blood pressure, and exercise affect the risk.

Students can be encouraged to take the initiative. Increasingly, they are. For example: In one junior high school, students are creating anti-smoking messages to go on bulletin boards, in classrooms, student publications, and mailings. In another junior high, overweight students volunteer for jogging every week. Others are petitioning the

cafeteria to cut down on junk food.

Though such programs may help children get on track, the primary responsibility remains with parents. Says Dr. A. Razzak Tai, chief of cardiology at St. Joseph's Hospital, Stamford, Conn.:

"When parents don't smoke, kids tend not to smoke. On the other hand, it's not convincing for parents who smoke to tell their children, 'I wish you didn't do it because I'm hooked.'

"We find that when kids are brought up in a household that says you're not to eat fatty foods, a very large number of these kids don't like fatty foods for the rest of their lives. So I believe a family's way of life most influences what children do when they grow up."

ories as carbohydrate or protein.

Don't switch from fats to simple carbohydrates such as sugar. This is believed to increase the likelihood of diabetes—which doubles the risk of heart attack.

5. Exercise prudently. According to the long-term Framingham study, moderately active people have about half as much heart disease as those who get little exercise. Other studies fail to show that exercise actually reduces mortality, but doctors tend to agree that exercise helps the heart.

All kinds of exercise can be beneficial. The best are regular and rhythmic—like bicycling, swimming, jumping rope, jogging. Distance is more important than speed.

For people who have been sedentary for years, a sudden burst of exercise may be dangerous. It's smarter to build up your capacity gradually. In any case, before engaging in a vigorous exercise program, you should check with your doctor. A stress electrocardiogram should reveal if hidden heart disease exists.

Perhaps the ideal exercise is the kind you can do every day, for the rest of your life: walking. It burns calories without increasing your appetite. It helps your body absorb oxygen more readily. It conditions your heart to pump more blood with each stroke and get more rest between strokes.

Walking stimulates the growth of additional vessels which maintain blood flow even when arteries become clogged. This collateral circulation, as it's called, can help prevent a heart attack. Should an attack occur, collateral circulation can be a lifesaver.

Walking, by compressing the leg muscles around veins, helps pump

blood back to the heart. Thus improving circulation, walking helps protect against deadly clots.

Potassium is essential for a healthy heart; deficiency can trigger irregular heart beats. Body cells contain about 90 percent of potassium, while 3 percent circulates in the bloodstream. Prolonged inactivity can lead to excretion of potassium by the kidneys. But walking reduces this. It also causes cells to release potassium into the bloodstream where it can become available to the heart.

A prescription for a long life is sure to include this: walk at least an hour each day.

6. Take time to relax. Dr. Meyer Friedman and Dr. Ray Rosenman reported in their book, *Type A Behavior and Your Heart*, that relentlessly competitive, hurried, hostile people have a higher risk of developing heart disease than people who are more able to take things in stride. Type A behavior, as these doctors dubbed the hurry-up kind, leads to a higher cholesterol level.

So doctors recommend that you slow down:

Think about only one thing at a time.

Cultivate friends who can achieve their goals without being frantic.

Don't mix business with meals, family affairs, and other opportunities to relax.

Many people find meditation helps.

Take vacations that get you away from the everyday grind: for example, go camping, fishing, or hiking—in other words, non-competitive pursuits.

And every day, go for a walk; it's an unbeatable tonic for relieving tension and providing a feeling of well-being. ■

by Ren Frutkin

Will a solar home save you money?



Not so readily as you may have been led to believe.

Or so I came to learn after nearly eight months of research on various solar projects. Despite the allure of "free" energy and independent living that residential solar systems seem to promise, the chief reward for the sizeable investments involved may not be monetary—at least not for a long time.

Energy pioneering, environmental banner-carrying, the chance to be the talk of the block—yes. Reasonable return on investment? Not much and not yet.

Why? The answer lies in three areas: insulation, initial costs, and annual savings.

Let's consider insulation first—and "insulation" includes the whole range of design features and construction techniques that can save energy in a home. An analysis of the costs and benefits of energy-saving house design is staggeringly impressive. An outlay of 2 to 3 percent of the construction costs of a new home can buy enough energy-saving features to save 50 percent on fuel bills. Many of the savings come from common-sense design—placing windows on the south side instead of the north, for example. Most of the money goes into buying extra attic and wall insulation, thermopane windows, attic fans, etc.

On the other hand, what will the addition of a solar system do for

the same house? A solar hot water and space heating system for a 2000-square-foot home, where I live in South Carolina costs \$7000 to \$10,000. It adds only 20 percent to the energy savings already gained by extra insulation—clearly an underwhelming cost/benefit ratio. Add to this that the solar package does not include air conditioning (and that winters in the area are mild) and the solar horizon remains clouded.

The second point is that the high initial cost for solar systems seem to hold true throughout the solar spectrum—in large buildings and small ones, in less-than-total systems and in more extensive ones. For example, roughly the same proportion of costs and benefits holds true in the world's largest solar heated-and-cooled building, a community center and indoor ice-skating rink.

An example of a less-than-total solar system is the solar hot water heater. Most people in the solar industry say that it offers the best return on investment and has mass-market potential. It's true that a surprisingly high proportion of energy in a home is used to heat hot water. Twenty gallons of hot water per person per day is the widely accepted design standard, and this can mean anywhere from 15 to 25 percent of monthly fuel costs. If you have a

large family and use a lot of hot water, however, the chances of your being able to afford even this piece of solar equipment are less than good.

Why? Because even a solar hot water heater is expensive by ordinary standards. A contractor in my area—one who really knows solar construction—quotes an installed price of \$2000 to \$2500 on new construction. Add another 20 percent for retro-fitting an already existing house. These prices are realistic expressions of the value of the equipment, labor, and profit (quite small, actually) involved—but compare them with the cost of a conventional hot water heater, which is a few hundred dollars at most.

Unfortunately, any number of bad practices in quoting prices whet the appetite of the unwary to own a solar hot water heater. One investment newsletter, puffing a certain manufacturer's products (and thereby its stocks), quoted a price of \$1400 for the equipment—without reminding the reader of the added costs of installation.

Another instance of confusion comes from a sophisticated financial writer in *New York Magazine* who says, "If you put \$1000 . . . into a solar hot water heater that cut your gas or electric bill by just \$10 a month, you would in effect be getting a \$120 annual dividend . . . [or] a 12 percent tax-free return." That sounds good, but it will take much more than \$1000 to get the job done well enough to generate that rosy financial picture.

The third and final reason that even a solar hot water heater may not save you much money is that utility companies still price their product in an extremely attractive way—the more you buy, the less it

costs, on a per-unit basis. For example, my utility company offers the following rate structure:

First 40

Kilowatt/Hours @ 9.0 cents

Next 160

Kilowatt/Hours @ 3.3 cents

Next 800

Kilowatt/Hours @ 1.7 cents

Over 1000

Kilowatt/Hours @ 1.5 cents

Fuel cost adjustment: 1.03 cents

per KWH additional

Now, where are the kilowatt-hours that you save with solar equipment going to come from—from the top or the bottom of the price list? From the bottom, where they're still amazingly cheap.

The reason for much confusion here is that if you try to figure anticipated solar savings and ask the utility company for its prices, they'll almost invariably give you an "average" cost per unit of power. This is the answer I got when I first asked, and it was a very high 4.5 cents per kilowatt-hour. But you won't be saving "average" kilowatt-hours. You'll be saving those inexpensive ones at the bottom of the list. Ergo, less savings and less return on investment. In fact, when I used my June, 1977, power bill (based on my usage of 1875 KWHs) to estimate the possible saving from a solar hot water heater, I found some large differences. Figuring that the solar equipment would reduce my power needs by 20 percent or 375 KWH's a month, the use of the "average" cost per KWH generated a 10 percent return on a \$2000 solar hot water heater. The saving based on *true* costs per KWH yielded a much less impressive 5.6 percent return.

Until utilities stop pricing energy as a commodity (with discounts for volume purchases), this picture won't change much. ■

Dangerous 'Wake Turbulence' Finally Is Defeated... With **WINGLETS**

by Don
Berliner

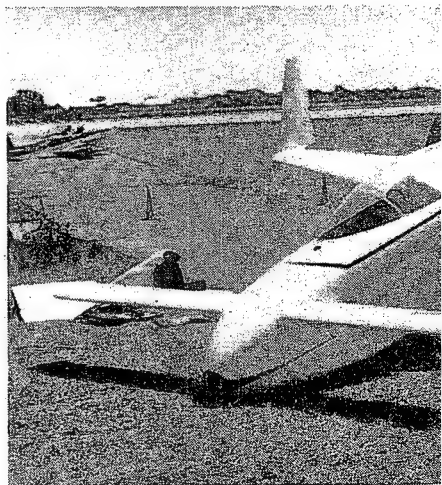
In the fall of 1978, if everything goes according to \$4 million worth of plans, an Air Force KC-135 aerial tanker will take to the skies to test a pair of gadgets on its wingtips that could significantly reduce aircraft fuel consumption and dissipate dangerous wake turbulence.

By the time the experimental craft begins its test flights, however, little doubt should remain about the value of the slender "winglets," for by then as many as 100 amateur-built airplanes could be flying with just such devices . . . and at a cost to the taxpayers of absolutely nothing.



When the talented team of aerodynamicists centered around Dr. Richard T. Whitcomb, of NASA's Langley Research Center near Norfolk, began its theoretical work on vortex hazards in 1970, little thought was given to contributing to sporting aviation. The goal was to reduce the increasingly dangerous vortices of air that swirl back from the wingtips of large planes—especially wide-bodied airliners—and create cones of forbidden territory. Wake turbulence, potentially catastrophic to smaller airliners, has been detected as far as four miles behind a 747. It is equally dangerous to light aircraft almost twice as far back.

As tests progressed, the need to conserve fuel acquired great priority. Researchers reasoned that if tip vortices could be reduced, a simultaneous drop in aerodynamic drag should occur, showing up as an improvement in fuel economy.



The idea behind the "winglet" is control of the spanwise flow of air from the high pressure area on the lower surface of the wing to the lower pressure area on the upper surface. This produces a swirling, expanding, invisible cone of turbu-

lence that stretches far behind the culprit, ready to attack anything that ventures into it.

For many years, designers had experimented with tip plates that were supposed to act as fences to stop this flow which had made the wingtip such an annoying source of drag. Tip plates, though of some value, created as much of their own drag as they eliminated. Still, there had to be *something* in the idea, and so the Whitcomb group decided to see if they could design plates which would reduce drag so much that they would more than counterbalance their own drawbacks.

The results of this work, published in 1974, introduced the "winglet," a device that bore absolutely no resemblance to any tip

plate ever seen, even though some similarity in function existed.

The "winglet" looks like a slender vertical tail attached directly to the top of the wingtip, with a smaller version attached to the bottom. Its job is partially to unwind the tip vortex, and simultaneously to reduce the wing's spanloading (the amount of lifting force needed from each foot of wingspan). The combined effect seems to be that the spanloading is reduced by as much as four times what might be expected from an addition the length of the "winglet."

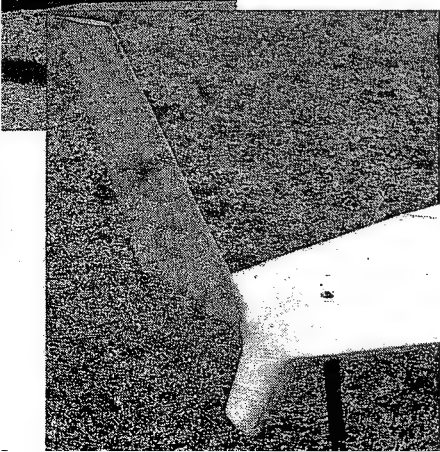
Whitcomb's crew at NASA developed the technique and showed by the use of wind tunnels and computers that it should accomplish significant improvements in several areas.

But it would be up to others to put the idea into practice. NASA's research results were there for all to use—as had been the case during many decades of developing such boons as efficient cowlings for the radial engine, and many fine series of airfoil sections.

The American aircraft industry studied the "winglet" with more than casual interest, for the problems of danger to other aircraft, and of staggering fuel costs are just too much to accept. But since no airplane had flown with "winglets" and demonstrated their advantages in real life, the manufacturers could do very little. Simply attaching "winglets" to existing airliners would not produce anything approaching the maximum value to be attained by designing an airplane expressly to use them.

Creating an entirely new, or even essentially new, airplane for the airlines is a task of enormously expensive proportions. In fact, only a few

The prototype "VariEze" kneeling to permit easy access to the engine. The nose wheel retracts. (Below): a winglet as mounted on Rutan's Vari-Viggen test-bed.



WINGLETS

American firms can even consider doing this without getting involved in cooperative programs, which spread the financial risk among many companies and many countries. And even this independence may be coming to an end.

But one facet of the aviation "industry" can charge into new ideas with little fear of losing anybody's shirt. The rapidly growing field of amateur-built airplanes involves the designing, testing, and—ultimately—the producing of plans and pre-fabricated components for small aircraft to be built by individuals for recreation and education. They do not require the tiring and expensive type-certification by the Federal Aviation Administration which their commercially-produced counterparts must have.

While such "home-built" aircraft are limited to non-commercial uses (no carrying of passengers or freight for hire), they can be used freely

Immense Savings in Jet Fuel Consumption Loom As Aerodynamic Drag Drops

for their owner's personal enjoyment. Since the FAA does not certify their safety, a plaque must be displayed in full view of anyone entering which designates it "Experimental." Under such conditions, an individual may build and fly an airplane of any design. Such experimenting by the industry with an idea as intriguing as the "winglet" could cost many millions, while a clever amateur might do it for a few thousand. And that's exactly what has happened.

Out in California, experimenter Burt Rutan simply called Dr. Whit-

comb at NASA and got the basic data by phone. In his shop at Mojave, he then built a new set of outer wing panels with "winglets" for his otherwise proven "Vari-Viggen" two-seat delta-winged home-built, and flew it. An experienced flight test engineer, Rutan quickly determined that the "winglets" were working, and proceeded to design a completely new little airplane to seize full advantage.

Disregarding the aeronautical maxim that you should never try out more than one new idea at a time, he created the "VariEze" with a radical construction—and a lot of cute little ideas mixed in. The airplane had a slender rear-swept wing mounted at the back (22½ feet in width), a horizontal tail at the extreme front, and its vertical tail combined with the "winglets" at either wingtip. Except for the large plexiglass canopy and a minimum of metal parts, everything was built of fiberglass-foam-fiberglass sandwich, producing an empty weight under 500 pounds.

Construction of the prototype—including development of building techniques—needed less than four months. The first flight was in May, 1975, and within a month it had been tested to the point that Rutan announced his intention to attack a series of world records for very light airplanes.

The first public appearance of his *VariEze* (pronounced "very easy" and referring to the simplicity of construction) in July was at the annual fly-in convention of the Experimental Aircraft Association. Experienced builders by the hundreds responded to Rutan's airplane and to the careful development which already had made it an airplane of superior performance. Immediately

after the fly-in, the designer's brother Dick, a career Air Force pilot, set a world closed-course distance record of more than 1,600 miles . . . in just over 13 hours, to average 125 mph and 41 miles per gallon.

Soon, the original Volkswagen car engine was replaced with a conventional aircraft engine—a 100-horsepower Continental—with which the popular Cessna 150 manages to cruise at 120 mph. But the improved *VariEze* cruises at 200 mph with two people, their luggage, and enough fuel to fly 1,000 miles. That's the kind of performance unmatched by factory airplanes selling for less than \$65,000—yet a skilled amateur can build a *VariEze* in a few months concentrated spare time, for less than \$10,000.

Detailed working drawings to the *VariEze* were published in July, 1976, and the first of the plans-built airplanes flew early this year. In June two "winglet"-equipped airplanes were displayed at the Paris Air Show: a German-built *VariEze* and a specially modified Israeli cargo plane.

The Air Force/NASA/Boeing

WINGLETS

project to adapt "winglets" to an aerial tanker (the military version of the Boeing 707) is expected to lift off about a year from now and to be completed about six months later. Wind-tunnel tests suggest an 8 percent reduction in fuel consumption, which the Air Force translates into an annual saving of about 45 million gallons of jet fuel. If this turns out to be accurate, you can expect future military and civil transport-type airplanes to sport vertical surfaces on their wingtips.

At the small, sportplane end of the performance spectrum, several thousand sets of plans to *VariEze* have been sold, and hundreds will become airplanes in the next few years. And that can be just a beginning. When Burt Rutan first hit upon his idea, he saw the two-seater as a flying test-bed for what he envisions as a six-passenger airplane cruising at well over 200 mph on just 150 horsepower.

The success of the *VariEze* hardly could have erased this dream . . . nor could it have failed to inspire others to try to achieve far more with less than has been attained before. ■

Solving the Research Crunch in Universities

(Continued from Page 29)

one of the strengths of American academic science" would fade and "some important links among disciplinary subfields or across disciplinary lines could very well be missed."

The State of Academic Science carefully states the problems and suggests the causes of academic scientific research's imminent downfall, but assiduously avoids offering any pat solutions.

An inescapable conclusion, however, is that the immediate solution should be an increase in the amount and constancy of federal funds available for non-specific research.

But whatever agency, department, or institution those funds are funneled through, ultimately they derive from a single source: the American taxpayer. If scientific research is to be saved, the taxpayer will foot the bill.

Surprise, surprise. ■

Horrors! But wait...those are only SIMULATED WOUNDS for use in first-aid training

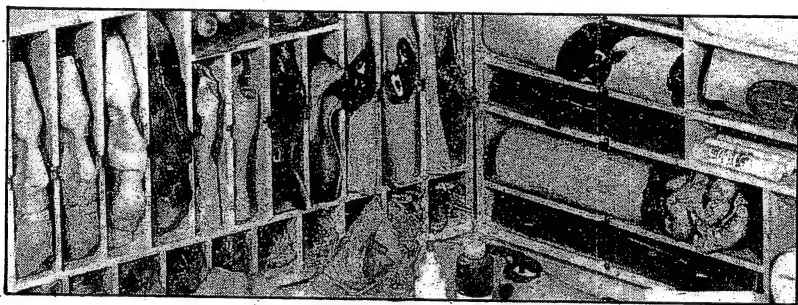
by David Lampe

Linda and Kevin Sweeney mass-manufacture mayhem. They create gaping wounds, broken bones, third-degree facial burns, bullet wounds, severe cases of shock, and frostbite. They also do a very fine line in arterial bleeding.

The Sweeneys, however, are not sub-contractors to organized crime. Or freelance hit people. Or ghouls,

the Sweeneys, "that *somebody* would have been able to give the first aid that could have saved that child's life."

If Kevin had been there, he would have helped—because he'd taken an Army first-aid course during the Korean War. And he recalled the sickeningly realistic rubber "wounds" that instructors taped on



Part of a 95-piece injury simulation kit.

or sadists. They make and sell simulated wounds to help save lives.

For several years after Kevin graduated in business administration from Columbia University, the Sweeneys lived in New York City where they both dreamed of ways to own a business of their own. Their lives took an unexpected turn one evening when a dinner guest arrived late, explaining that he'd stopped at the scene of an accident. A small girl had been run down, and not a single bystander had known how to help. "You'd think," their guest told

the bodies of GI "casualties." "Later," Kevin explained, "when faced with the real thing, we were less likely to panic, and more willing to render aid."

Brooding over the child's death, and discovering that paste-on wounds weren't available to civilian first-aid instructors, the Sweeneys finally upped stakes to retreat to Woodstock in upstate New York, to establish that business of their own. That was 15 years ago. Though not an artist, Mr. Sweeney sculpted the original clay model of the first

wounds that their new company (Simulaids, Inc.) marketed—open fractures of the tibia and of the humerus. "I simply took models of an arm and leg and then sculpted subcutaneous tissue and bone," he recalls. "Simulated wounds don't have to be 100 percent accurate, but we had the models checked by doctors, who made some very helpful comments."

The Sweeneys mailed catalogues showing their models to Red Cross workers and to physical training instructors, and orders started coming in, frequently from people who had seen the devices in the service but hadn't been able to obtain them.

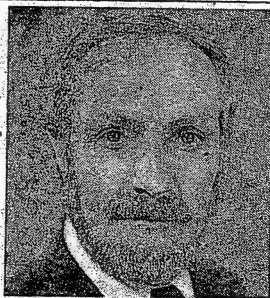
At first, the Sweeneys faced a lot of production problems. "We had difficulty," says Kevin Sweeney, "finding a contractor who could heat-seal small quantities of our 'blood' in the reservoirs."

Today, the Sweeneys—who certainly do not consider themselves producers of macabre novelties—tend to sell their wounds in kits rather than individually. Their most popular—and most expensive—kit is a 95-piece \$295 item originally put together for the Army. It is so complete that it can be used to stage major disasters. A recent demonstration by NASA at Washington National Airport gave first-aiders the opportunity to work on as many "victims" as they'd face in a major air disaster.

One item the Sweeneys sell separately is a bleeding device that can be used on its own or in conjunction with their attachable wounds. The "blood" (enough powder to make up 10 gallons is in the big kit) goes into a clear polyethelene envelope that the "casualty" wears under clothing. A concealed hand pump in the circuit pulses the blood. Some-

times the plastic piping from the reservoir to the plastic wound is routed so that the first-aid who applies pressure at the correct point actually stems or even stops the blood flow. As well as the "blood" for this device, Simulaids produces a ready-mixed variety that will coagulate realistically on or around artificial wounds. This substance is made with food coloring and thickening agents.

Simulaids' blood and wounds aren't intended to scare first-aid students. Kevin Sweeney explains: "Novices always are told beforehand that the wounds and the blood are synthetic—so they don't get sick or faint. And yet as they get used to working these things, the wounds become more real to them. But



Kevin Sweeney

they're also getting accustomed to them, and so learn to render first aid sensibly and calmly.

"The Army, in particular, finds this the best way to teach first aid practically to people never before exposed to trauma. And our strap-on and paste-on wounds are also very popular with ski patrols, fire departments and police departments."

The Sweeneys don't claim a monopoly on simulated wounds—fac-

SIMULATED WOUNDS

tories in Norway and England also make some, and so does a Connecticut firm, Alderson Research in Stamford—but they are indisputably the biggest in the business. Yet though they rely on their wounds for their livelihood, they speak admiringly of a massive British organization of wound simulators whose wounds are home-made. These people—banded together in an organization that traces to the World War II blitz, Casualties Union—take part in exercises all over England, not only as casualty “victims” but as sufferers of brain disorders and similar problems from epileptic seizures, or heart attacks, to deep shock. And they make their own “wounds”—with discarded nylon stockings (for skin), for example, or stale bread and mineral oil (kneaded together into “flesh”). The wax and theatrical make-up these people use have their counterparts in Simulaid’s kits.

Some Simulaid gaping wounds

even have glass splinters (well, smoothed Plexiglas) embedded, ready for first-aiders to tweeze out.

Simulaid also makes an artificial forearm—available with or without a hand—on which novice first-aiders practice intravenous injections. Of soft, life-like plastic, these are specially sculpted by an artist coached by physicians—and, for their purpose, are better than the real thing.

The Sweeneys supply—but don’t themselves manufacture—a full-sized casualty victim, heavy as an adult and programmable to be limp or rigid, to bleed, accept mouth-to-mouth resuscitation. Even his carotid pulse can throb realistically. And, of course, he can have broken bones or wear any of the plastic wounds—or even the “amputation.”

Plastic wounds are very durable, but the Sweeneys receive sufficient orders to keep their 12-person production line busy. And occasional new items are added—such as their new mouth-to-mouth resuscitation mannikin. ■

SCI/DI Quick Quiz

(1) The boiling point of water is lower when atmospheric pressure decreases. Therefore, *why not pump out some of the air* above the water in a kitchen pot, obtaining boiling water faster and saving some energy?

(2) A plane is flying along the perimeter of an equilateral triangle *ABC*. There is no wind, and the plane is flying at constant speed. The trip from *A* to *B* takes 1 hour 20 minutes, and the trip from *B* to *C* also takes 1 hour 20 minutes. *How come the trip from C to A takes only 80 minutes?*

(3) When you step outdoors on a

clear day you are surrounded by a vertical electric field of 100-500 volts per meter. The field is directed downward and is set up by the positive charge in the atmosphere. When a charged thundercloud comes along, the field may go up to 10,000 volts per meter. *Why doesn't this voltage kill you?*

(4) A tramp, walking down a road, comes to a place where five roads meet and finds the signpost lying in a ditch. No one is in sight, it is a cloudy day, and he has no compass. *How can he tell which road goes to the town he is heading for?*

(Answers on Page 99).

Sawdust Steaks In Your Future? A Brake on the Grain Drain . . .

by Mitch Lobrovich

Within the next few years you'll probably find yourself poking through the meat bin at your supermarket, selecting a cut of choice sawdust-fed beef. A revolutionary conversion process is coming into use across the country.

Long considered useless refuse, the billions of pounds of sawdust and other cellulosic waste, such as cotton gin trash, peanut hulls, and sugarcane bagasse that pile up each year, now can be viewed as tons of potential animal feed.

For nearly a century, scientists in a dozen nations tried without success to break the lock on the significant food value in sawdust (which contains 70 to 80 percent carbohydrates). J. W. Jelks, a mechanical engineer in Sand Springs, Okla., finally made the breakthrough. By hydrolyzing sawdust—injecting it with steam and acids under pressure—he converted it into a low-cost cattle feed concentrate.

Since Jelks opened his pilot plant in 1973, beginning lengthy field tests, his patented process has been under scrutiny by a number of universities, private firms, and the federal government. All have turned in positive reports. The most recent study, by the Economic Development Administration, U.S. Department of Com-

merce, concluded that by using Jelks' method, "hardwood sawdust can be converted into a very palatable, economical replacement for grain in ruminant (four-stomached animals) feeds."

The report places the value of properly hydrolyzed hardwood sawdust as an ingredient in cattle feed as up to 80 percent of ground shelled corn—yet the production cost is less than half that of corn.

"In some field tests, the converted cellulose material actually has outperformed corn in putting gain on livestock," says Thomas Winn, president of Houston-based Charter Financial Group, Inc., the U.S. licensing agent for the process.

The converted cellulose product, tentatively named Econo King, was first tested on dairy cattle owned by Joe Whetstine of Cabool, Mo. After experimenting with small amounts, Whetstine took his 100-head dairy herd off corn completely in March, 1976, and fed it exclusively on a ration of 70 percent converted sawdust and 30 percent soybean meal. (By comparison, corn, in percentages ranging from 60 to 80 percent, routinely is mixed with such additives as alfalfa, protein, and minerals.) The results were monitored monthly by the computer center at Iowa State University. Computer printouts showed that, on the new diet, the herd's milk production and butterfat content both increased by more than 10 percent, while feed costs decreased by approximately 20 percent.

Tests with beef cattle at Texas Tech University found that in some cases when sawdust replaced a portion of the grain, "cattle gained at a faster daily rate than those on other rations," said Dr. Robert C. Albin, professor of animal science. ➔

SAWDUST

It also was learned that fatty acids produced by the Jelks process are highly efficient in reducing the amount of feed required to produce a pound of gain. This is because fatty acids can be absorbed directly into the blood and quickly converted to fat.

Some credit for all this must be given to the Germans, who during World War I succeeded in converting sawdust into a feed with a food value equal to prairie hay (40 percent the value of corn). It was enough to keep cattle alive, but was intended only as a maintenance feed. Once grains became available again, it was dropped from large-scale use.

A billion cubic feet, converted as an energy source, could have a profound effect on economy.

Experimentation continued with treated and untreated sawdust in ruminant feeds, but its practical use was limited to 10 to 25 percent of the total diet, and a number of researchers concluded that it never would be economically feasible to treat sawdust for cattle feeds.

The main stumbling block was lignin, the material which binds energy-packed cellulose together to form the woody cell walls of plant material. The basic components of cellulose are starches and sugar which provide nutrition and energy, and cause substantial weight gain. The lignin-cellulose bond in untreated sawdust is so strong that cattle can't digest the cellulose.

Jelks finally broke the seemingly impregnable lignin bond, after a ten-year struggle, by employing what is essentially a huge pressure cooker.

By using a concentrated acid and a catalyst, extreme heat and pressure in a two-step cooking process, he broke down the lignin-cellulose bond; partially hydrolyzed a large amount of the cellulose into starches, sugars, and saccharide acids; and rendered a large portion of the carbohydrates digestible.

Another plus, according to Tom Winn, is that cattle feeding on converted sawdust over a long period have remained unusually healthy. The reason was unknown until recently, when research by German scientists revealed that lignin apparently has an antibiotic quality.

Several commercial plants now are converting sawdust waste into cattle feed. Cost per ton of formulated sawdust feed (with protein, vitamins, and minerals added) is about \$80 a ton, compared to \$100 and up for any other good quality feed on the market. Earliest plants were at Frohna and Cabool in Missouri, and at Rockville, Ind. This fall, plants were added at Houston, Bastrop and Tulia, Texas; and at Spokane, Harrisburg, and Tulsa. Winn projects another 20 plants to be licensed by the end of this year.

With the forest products industry annually producing more than one-billion cubic feet of sawdust that is going to waste, a concerted effort to convert this by-product into an economical and satisfactory source of energy in cattle feeds could have a profound effect on the country's economy.

From a global standpoint, hydrolyzing cellulose waste could free up, each year, several hundred million pounds of grain that otherwise would be fed to animals, but could be made available for human consumption as the world's population grows larger and hungrier. ■

August 12, 1977.



The Space Shuttle "Enterprise"
glides to the desert floor
near Edwards, California.

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(Cont'd. from P. 55)

Already in orbit is the experimental Communications Technology Satellite, a joint venture of Canada and the United States. Its signals can be picked up by small portable dish antennas only 1.5 meters across. Studies show that such a system can aid education and medicine, as well as basic communication itself. A major education program was established by India using NASA's ATS-6 satellite, which beamed news, farming and medical

Dick Tracy's two-way wrist radio may not be that far from reality. In an address to the Conference on Satellite Communication and Public Service, NASA's then chief, James Fletcher commented on the possibility of gigantic satellites, some 150 feet in diameter, directing some 25,000 discrete signals to earth antennas no larger than watch crystals. These ground transmitters probably could be made for less than the cost of an inexpensive watch.

As have other areas of space research, communications satellites have come a long way in a short time. Little more than a decade ago, cables, ships, and planes were the only dependable means of transoceanic communication. Orbiters have changed all that, and today they make calling overseas just as easy as calling next door. ■

Here's the third in the TIGO

In each row and column with an “=” sign, arrange the four numbers shown at the top, together with one “+”, one “-”, and one “×”. The result of each arrangement must equal the answer printed. In each equation, use each number and each sign only once. Negative values are not permitted. It is assumed that parentheses surround all terms to the left of the “×” sign. © 1977 Ward & Sons.

This puzzle is similar to those in the "First Book of TIGO Puzzles," sold by TIGO, Box 2941, Spartanburg, S.C., 29304 (\$1.75).

Checkup on Medicine

The Beginning of the End for the Virus?

✓ In an advance that has been compared in importance to the first clinical use of penicillin in 1941, medical researchers have found a drug that can be used to treat a usually-fatal virus. In human trials, the drug, called adenosine arabinoside, or ara-A, was given to people suffering from herpes simplex encephalitis, a rare virus that attacks the brain and is fatal about 70 percent of the time. The mortality rate of the group treated with ara-A was reduced to 28 percent, and less than 50 percent of the patients who survived suffered after-effects from their illness, especially when drug treatment was begun in the early stages of the disease. Research on the drug was carried out by the National Institute of Allergy and Infectious Diseases, Parke-Davis & Co., and by a number of other research labs.

A member of the purine nucleoside class of chemical compounds, ara-A was first isolated 20 years ago from a type of Caribbean sponge by two French scientists looking for anti-cancer

agents. It was isolated again in 1963, at Parke-Davis, from a soil sample collected in Italy. Ara-A's importance stems from the fact that viruses are active only after they have entered a cell; thus, to prevent the virus from multiplying and causing disease, an agent had to be found that could penetrate the cell and attack the virus without damaging the cell itself. Ara-A is the only drug effective against a virus that can be safely taken internally; it also differs from other virus treatments, like the polio vaccine, in that it is effective after the virus has spread.




Although ara-A is useful against only a narrow range of viruses—and therefore is not really in the same league as penicillin, which can be used against a broad spectrum of bacteria—scientists are confident that compounds analogous to ara-A can now be developed to treat other forms of virus. Under the generic name Vidarabine, the drug has been available for about a year as an ophthalmic ointment to treat an eye virus that often causes blindness.


Human Sexuality: A Powerful New Drug for Normalcy

✓ A drug called bromocryptine, first synthesized about five years ago in Switzerland, has shown the ability to correct a wide variety of sexual disorders in both men and women by suppressing the excess secretion of prolactin, a


pituitary hormone. In women, the drug—which is available on an experimental basis in the U.S.—has been able to return interrupted menstrual cycles to normal, alleviate depression, and restore dormant sexual desires to normal; in

Checkup on Medicine

men, the drug has also been able to revive libido, as well as reverse impotence by restoring sperm production (spermatogenesis).  According to the Worldwatch Institute, there are now more couples using sterilization to prevent pregnancy than any other preventive family-planning measure; at last count, there were 75 million couples relying on sterilization, up from four million in 1950.  An Oklahoma surgeon has come up with an improved method for reversing vasectomies. Dr. Joseph W. Hayhurst uses a microsurgical technique originally developed in Australia to sew back together the ends of the vas deferens, the sperm-carrying tube.  A physical chemist has recently patented a reversible, non-surgical method of birth control for


women. The process uses rubber-like silicone plugs to block the ends of the fallopian tubes; each plug has a tiny ring in it to allow easy withdrawal with a special instrument.  According to a recent study by two scientists in the Department of Population Dynamics of the Johns Hopkins University, between 1971 and 1976, sexual activity among unmarried women aged 15-19 increased by a surprising 30 percent; over half of the sample of 1900 women had had intercourse by age 19, with the average age of first intercourse dropping from 16.5 to 16.2. The study also showed that despite a 3 percent increase between 1971 and 1976 in the proportion of respondents who knew the time of greatest risk of pregnancy, the 1976 proportion was still a very low 41 percent.

Scanner Works Like a Bat To See Inside the Body

 Researchers at the National Institutes of Health have developed an inexpensive ultrasonic scanner that operates on the same principle as the sound-echo navigational system of bats to provide a cross-section view of the abdomen. The scanner sends out pulsed signals that in turn produce echoes from various tissue

boundaries in the body; the scanner converts those echoes to continuous electronic signals that can be seen on a tv screen. Among other applications, the device can be used to study normal physiological activity in the abdominal area, as well as to detect tumors, vascular abnormalities, or stones in the gall bladder.

Procedure Found for Turning Cells On or Off

 A process that can both stimulate and block cell division and proliferation has been developed by Dr. Clarence D. Cone, Jr., a biomedical researcher in Hampton, Va. The method, which is patterned after normal human mechanisms for changing electrical

potentials across cell membranes, eventually may help in the treatment of brain and spinal injury, and senility, by effecting the replacement of nerve cells. The method may also help scientists learn how to reverse or inhibit the uncontrolled spread of cells.

Food and Health: Diets, Additives, Cholesterol, & Salt

✓ Researchers at the University of Illinois College of Pharmacy are testing a new drug called perfluorocetyl bromide that could make diets obsolete. The drug, which does not react with, and is not absorbed by, anything in the body, coats the intestines and stomach lining to prevent the absorption of up to half the calories, carbohydrates, and fats in a full repast. The food additives controversy continues to boil. A California physician, Dr. Benjamin F. Feingold, has claimed that synthetic food additives can trigger hyperactivity in children, and that additive-free diets can return many children to normal behavior. Researchers at the University of Wisconsin-Madison tested the hypothesis in a carefully-controlled eight-week study involving 46 children, and concluded that food additives do not cause hyperkinesis. But the fact remains that the average American ingests more than five pounds of synthetic additives each year, in some 4000

different chemical forms. A booklet on the topic, free for single copies, 30¢ per copy for more, is available from Today's Food and Additives; P.O. Box 6095; Kankakee, Ill., 60901. In the past two decades, researchers report, the cholesterol levels of Americans have dropped 5 to 10 percent, which parallels a 10 percent drop in the number of deaths from cardiovascular disease. A surprising piece in the hypertension puzzle has come out of a University of Iowa investigation of the effect of salt on blood pressure. Researchers found that in patients with slight hypertension, excess salt in the diet raised blood pressure and constricted blood vessels, while in normal patients, excessive salt did not elevate blood pressure and actually caused blood vessels to relax. The finding may have important implications for the diagnosis and treatment of individuals with a predisposition towards hypertension.

New Drug Shows Promise Against Lung Disease

✓ Prostacyclin, a powerful compound in the body that was discovered only last year and already has been shown to play an important role in blood clotting, now holds promise as a treatment for obstructive lung diseases like

bronchial asthma. In laboratory animals in which bronchial constriction was induced either pharmacologically or immunologically, prostacyclin was able to effect significant dilation, or opening, of the closed air passages.

A Rosetta Stone for Doctors' Prescriptions

✓ To many consumers, a doctor's prescription is an indecipherable hieroglyph that only pharmacists can decode. Yet knowing what drug has been prescribed, and in what strength, makes it possible

to comparison shop and have the prescription filled at the lowest price. To help consumers understand what the doctor has ordered, the Food and Drug Administration is offering a free reprint

Checkup on Medicine

called *Reading Prescriptions*, copies of which can be obtained

by sending a postcard to the Consumer Information Center, Dept. 667E, Pueblo, Co., 81009.

Psychotherapy That Doesn't Take Forever to Work

✓ Specially-trained therapists at the University of California San Francisco's Psychotherapy Evaluation and Study Center are using an innovative time-limited approach to help people work through disturbing stress events like rape, divorce, bodily injury, or death—in about 12 hours' time. The program, developed by psy-

chiatry professor Mardi J. Horowitz and based on the theory that the natural healing process of the mind involves five recognizable phases of reaction to stress events, aims to identify which phase a patient is in, and then help to complete the remaining phases. The 12 hours may extend over six weeks to three months.

Man's Best Friend Indicted in Multiple Sclerosis Study

✓ There may be a relationship between prolonged close contact with house pets and the subsequent onset of Multiple Sclerosis, according to two studies recently carried out in New Jersey and published in the British medical journal *Lancet*. Out of 29 MS patients, Drs. Stuart D. Cook and Peter C. Dowling found that all

but three owned small dogs (two of the three non-dog owners owned cats). In support of Cook and Dowling, Dr. Seymour Jotkowitz reported that out of the 50 MS patients examined, 46 of them had had close contact with a house pet prior to the onset of the disease. Some pets were eventually diagnosed as having distemper.

Cold Water Drownings May Not Be Fatal

✓ It has long been assumed that drowning victims cannot survive for more than four or five minutes under water, since after that length of time the brain begins to suffer irreversible damage due to oxygen deprivation. But Dr. Martin J. Nemiroff of the University of Michigan Medical Center has reported a number of cases in which people were submerged for as long as 38 minutes and recovered without impairment. Dr. Nemiroff suggests that the victims were saved by a "diving reflex" that is activated in water colder than 70° F. First identified in seagoing

mammals like whales and porpoises, the diving reflex slows the heartbeat and restricts the flow of blood to the skin, muscles, and other tissues—whose need for oxygen is reduced by the cold water—and directs the remaining blood oxygen to the heart and brain. Thus, Dr. Nemiroff warns, though people who have drowned in cold water may be cold, blue, not breathing, and lacking a detectable pulse or heartbeat, rescue workers should not give up easily in their efforts to resuscitate them.

—Neil Gluckin.

About 7000 people in the U.S. are killed by residential fires each year—75 percent of them during the night. Up to 60 percent of those lives might have been spared by smoke alarms

Roger Field's Consumer Notebook

Buy Your Smoke Detector With Care

Fire is the nation's third leading accidental killer, trailing only automobile accidents and falls. Perhaps most alarming in our *per capita* rate of fire deaths, nearly twice that of any other country.

True, this may be related to the American propensity for smoking, drinking to excess, and upholstered furniture. But a solution has emerged in the form of some new technology: the household smoke detector.

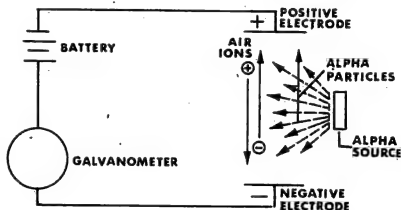
Sensing heat is, of course, nothing new. What is new, however, is the availability of small easily installed units of modest price that sense smoke—even smoke consisting of particles so small you cannot see them. Such devices are now made by at least 80 manufacturers. They sell for about \$30 to \$50. Some contain batteries to drive the smoke-sensing circuit and power the alarm; others plug into a nearby electrical wall outlet.

But all have two things in common: they can be installed in ten minutes by anyone with a screwdriver. And in the event of fire, especially at night, they can save your life and your family's. In fact, so effective are some new smoke detectors that many communities are starting to write amendments into building codes to require them in new dwellings.

Surprising then, considering the almost instant acceptability, that manufacturers are quibbling about which smoke-detector technology works best. Basically, two forms are

available that operate on rather different principles.

Most impressive is the so-called "ionization smoke detector," triggered by smoke particles far too small to see. Its heart is a radioactive source that continually puts out harmless alpha particles (the nuclei of helium atoms). These are positively charged ions that are rather weighty, consisting of two protons



Ionization chamber principle.

and two neutrons. What happens is that alpha particles come charging out of their source material to ionize molecules of air by knocking electrons off these molecules or by attaching themselves to them.

Since the alpha particles have a charge of $+2$, either outcome yields an ion with electrical charge. Negatively charged molecules that attracted an alpha particle become positively charged; neutral or positively charged molecules losing an electron or two become negatively charged. Either way, the resulting ion population then drifts towards the oppositely charged electrodes of a collector, creating a tiny, constant electric current. For reasons not en-

SMOKE DETECTORS

tirely understood, but relating to their origin, smoke particles almost invariably possess an electrical charge. Drifting into the electrode area, but too massive to move swiftly toward either collecting plate, the smoke particle bumps into and neutralizes those faster moving ions. The otherwise constrict trickle of current drops. Special sensing circuits detect this drop and trigger the alarm, which usually consists of a loud bicycle horn that could wake the dead (but presumably won't have to). Generally, these ionization detectors are the best units for quickly sensing the presence of flaming flash fires that produce little visible smoke.

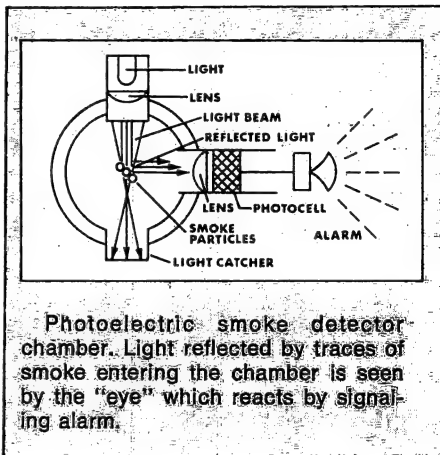
On the other hand, larger visible smoke particles are best sensed by a *photoelectric detector*. In this unit, light from a small bulb shines across a dark chamber and is totally absorbed by a light trap on the other side. Peering perpendicular to the beam is a light-sensitive photo cell. The presence of smoke particles large enough to be seen causes some light to be reflected in the direction of the cell, which picks it up and sounds the alarm. In general, bulb-operated photoelectric detectors require too much power to run on batteries. And they are best suited to detect smoldering fires started, say, by a burning cigarette left on a mattress or an upholstered chair.

Makers of each type of smoke detector make a big point of the different response times to these two kinds of fires. But experts say a well-designed detector of either type can save lives, no matter how the fire starts. And, of course, consumers with larger dwellings requiring two detectors would be well advised to buy one of each type. (See accom-

panying article, "What to look for.")

What is clear, however, is that many makers, in their rush to cash in on the public's understandable fear of fire, have introduced less-than-perfect smoke detectors in both categories.

The expert at the National Bureau of Standards in charge of setting standards for smoke detectors—Richard Bright—reports that tests



conducted at the Bureau show each detector technology has its place. A flash fire with little visible smoke may be detected in one to two minutes, but with flames spreading rapidly the family may have just one or two minutes more to get out of the house. A smoldering fire may not be detected for up to two hours, but the family then might have another hour or two to leave before being overcome by toxic fumes. He also points out that an ionization detector is more likely to be triggered falsely by open-flame cooking. So if you plan to locate a detector near the kitchen, it should be a photoelectric unit.

Here's What to Look for in Detector Units

To cover all bets, many experts say your home fire detection system should consist of at least two units: a battery-powered ionization model (to catch open-flame fires and to function during power outages) and a plug-in photoelectric detector (to catch smoldering fires and to function when the other unit's batteries are dead). Also worth considering are the more expensive plug-in units that also have continuously recharging back-up batteries.

Regardless of the brand you buy, your smoke detectors should meet several standards that fire experts regard as important. First, the unit should be approved by Underwriters Laboratories (UL) or Factory Mutual (FM). The seal of either of these independent testing organizations assures you that your detector meets minimum performance standards.

Your detectors should also have signals to warn you when they're not working. For instance, battery-powered models generally beep or flash a light for several minutes daily for a week or more to signal that their batteries are going dead. In plug-in detectors, a pilot light should blink off to let you know of a power failure, blown fuse, or tripped circuit breaker. Photoelectric models should warn you if a bulb burns out—the usual signal is a buzz or a wail.

Once you've installed detectors, check them weekly. Some makes have a test button or lever. To test others, you must blow smoke into

them, either from a cigarette or a snuffed candle. Lightning, incidentally, can send a voltage surge through your house wiring that could damage a plug-in detector, so be especially vigilant about checking after storms.

Sometimes cooler temperatures weaken batteries—thus, if you cool your house considerably at night, your smoke detector may buzz to let you know its batteries are weak. To shut off the buzzing, you may remove the batteries and go back to sleep, forgetting to replace them in the morning. Therefore, some detectors feature a warning flag or a winking light that goes off to let you know your batteries are not on the job.

A small pamphlet, *Smoke Detectors*, is available from the Consumer Information Center, Dept. 645E, Pueblo, CO., 81009. It was developed by the National Bureau of Standards.

Also, check with your insurance company. Some companies now reduce your homeowner's policy up to 2 percent if you have an approved alarm system.

Where should you buy? Be wary of high-pressure door-to-door salesmen. Detectors are sold at hardware, department, or electrical supply stores. Or check your telephone book's Yellow Pages under "Fire Alarm Systems" to find qualified dealers.

—Richard Wolkowicz in
The Elks Magazine, March, 1977

Improvements can be made in the designs of individual detector models, rather than in the technology by which they work. For example, Mr. Bright points out that some detectors are so designed that

smoke can enter their detection chambers only with great difficulty. To work at all, such detectors would require smoke to move with considerable velocity—for example, 50 feet a minute—whereas smoke traveling



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SMOKE DETECTORS

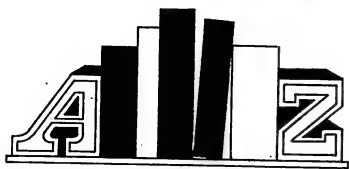
through dwellings may move as slowly as seven feet a minute.

As a practical matter, whether or not smoke gains access to the interior of a detector—according to tests conducted at the National Bureau of Standards—sometimes depends on the way it is mounted and positioned. Generally, smoke encountered no difficulty gaining access to ceiling mounted detectors. But some intended for wall-mounting—especially photoelectric detectors designed to be wall-mounted—created thermal barriers that prevented smoke from entering. Obviously, smoke that doesn't enter a detector cannot trigger an alarm.

Finally, the question of hazardous design. For your own peace of mind, you may wish to investigate and consider one of the *two detectors that seem to perform better than the others*. While experts won't go on record endorsing any one brand over another, the inside word among smoke detector authorities does pinpoint the following two models as being substantially better than others.

Those two units are: the *Pyr-A-Larm Model FB-1*, made by Pyrotechnics of Dublin, Ga., 31021, and the *GE Model 8201-2* made by General Electric. Both are ionization detectors designed specifically to detect smoky smoldering fires rapidly as well as flaming fires. And the latter unit by GE is the first smoke detector made on a single chip of silicon that has gained UL approval. It can be identified by opening it up and finding virtually nothing inside—an almost empty housing contains a tiny microcircuit, a couple of small components, and a small black electronic horn, plus a battery!

Books in Digest



The Inner Planets. Clark R. Chapman. Scribner's. (\$7.95). New light on the rocky worlds of Mercury, Venus, Earth, Moon, Mars, and the asteroids.

Perpetual Motion: The History of an Obsession. Arthur W. J. G. Ord-Hume. St. Martin's Press. (\$15). Frustration and futility from the beginning. "The fascination of the subject is not quite dead: Today in the laboratory the phenomenon known as superconductivity has actually made possible a form of perpetual motion."

Migration to the Stars. Edward S. Gilfillan, Jr. Robert B. Luce, Inc. (\$8.95). In that "we have outgrown the earth," the author offers an argument for space colonization; he finds "nothing that can stop us."

The Future of Science. Timothy C. L. Robinson, editor. John Wiley & Sons. (\$12.95). Talks at the eleventh Nobel Conference in 1975 at Gustavus Adolphus College by three laureates and a theologian who examine science from a variety of aspects.

The War Animals. Robert E. Lubow. Doubleday. (\$7.95). The training and use of animals as weapons of war, including a greater variety than you might expect.

If the Patient Is You (Or Someone You Love). Milton H. Miller, M.D. Scribner's. (\$9.95). Psychiatry, from the patient's point of view: "What is it like to be schizophrenic, neurotic, perverse? These are the key questions that must be answered before choosing treatments. . . ."

Ecology Out of Joint. Lorne J. and Margery Milne. Scribner's. (\$8.95). The theory that "our entire ecological order is tumbling into chaos."

Ecological Sanity. George Claus and Karen Bolander. David McKay Co. (\$16.95). Attempt to refocus aims and methods of the ecological movement from "reactionary" to "revolutionary," advocating a more scientific interpretation of facts. "A critical examination of bad science, good intentions, and premature announcements of the ecology lobby."

Pigeons and Doves of the World. Derek Goodwin. Cornell University Press. (\$27.50). An out-size authoritative guide to all living or recently extinct species; profusely illustrated by Robert Gillmor.

Cancer and Chemicals. Thomas H. Corbett, M.D. Nelson Hall. (\$8.95; \$5.95 paperback). Chemicals that pollute our environment, where they are, how they got there, their effect on health and well-being.

Genetic Evolution. Chen Kang Chai. University of Chicago Press. (\$20). Innovative, comprehensive theory of the subject by a researcher who views life as a self-generating information system.

Adventures of a Mathematician. S. M. Ulam. Scribner's. (\$4.95, paperback). Recollections of one who was among the pioneers in computer use in scientific research and who was co-author of the paper behind the H-bomb.

Rays of Hope: The Transition to a Post-Petroleum World. Denis Hayes. W. W. Norton & Co. (\$9.95; \$3.95 paperback). Arguments on behalf of solar power.

Biohazard. Michael Rogers. Knopf. (\$8.95). The controversy on recombinant DNA research. ➔

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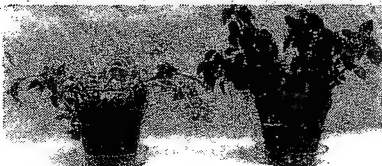
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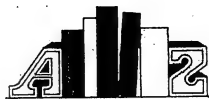
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Books Continued



Larousse Guide to Minerals, Rocks and Fossils. W. A. Hamilton, A. R. Woolley, A. C. Bishop. Larousse & Co. (\$6.95, paperback). Arranged as a field guide for rapid, accurate identifications.

Beyond Biofeedback. Elmer and Alyce Green. Delacorte. (\$10.95). Reporting on research at the Menninger Foundation of the mind's power to control the body and its unconscious functions, emotions, and states of consciousness.

The Secret Lives of Fishes. Bernard L. Gordon. Grosset & Dunlap. (\$12.95; \$7.95 paperback). A series of relatively brief notes on the "fascinating... frightening facts" about 70 different fish.

Insect Life. Michael Tweedie. Taplinger. (\$8.95). Delineating insects' place in the world, their diversity, and role in maintaining the balance of nature.

Astronomy—Structure of the Universe. A. E. Roy and D. Clarke. Adam Hilger Ltd. (Bristol); Crane Russak (New York). (\$24.50; \$14.50, paper). Writing for students and serious amateurs, the authors move in the traditional way from the solar system to cosmology. They derive useful mathematical expressions throughout and invoke simple calculus as occasion demands. A casual reader may ignore this, but the simple exposition and wealth of subjects make this textbook (complete with exercises, problems, and answers) a very useful reference work for teachers using a different book. Ideally, one should also possess what is virtually a first volume to this second one: *Astronomy—Principles and Practice*, by the same authors. Using them together, an amateur could feel astronomically invincible.

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Outlook
- How to Handle Holiday
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Looks at Anxiety, Guilt
& Blues
- And a Baker's Dozen of
other featured articles

Quick Quiz Answers (See Page 78).

(1) Who needs boiling water at a temperature of, say, 70° C? You could safely put your finger in it. Meat, eggs, and vegetables would take forever to cook at such a low temperature. Medical instruments could not be sterilized, and so on.

(2) Because 80 minutes = 1 hour 20 minutes.


(3) There is no voltage on you. A person standing outdoors is a grounded conductor, and his skin is an equipotential surface like the surface of any conductor. The voltage on his skin is everywhere the same and equal to the voltage of whatever he is touching. But he is touching the ground, which has zero voltage, so he is in no danger.

(4) We must assume the tramp is sober enough to remember where he came from. All he has to do is replant the signpost so that the correct arm points back where he came from. The remaining four hands automatically will point in the right directions.

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Tigo Answers (See Page 82).

2 4 6 9

6	-	2	x	4	+	9	= 25
-		x		x		-	
4	+	6	-	9	x	2	= 2
x		+		+		x	
9	+	4	x	2	-	6	= 20
+		-		-		+	
2	+	9	x	6	-	4	= 62
=		=		=		=	
20		7		32		46	

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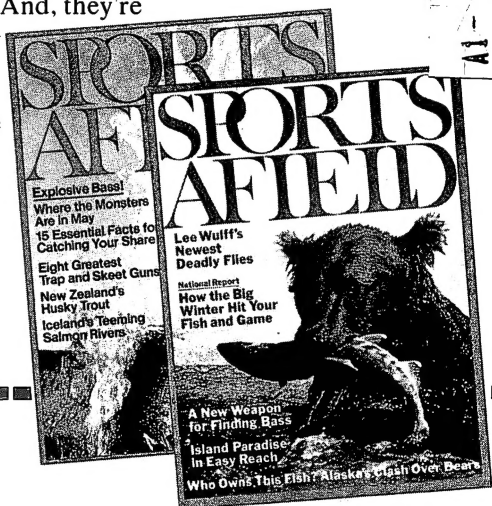
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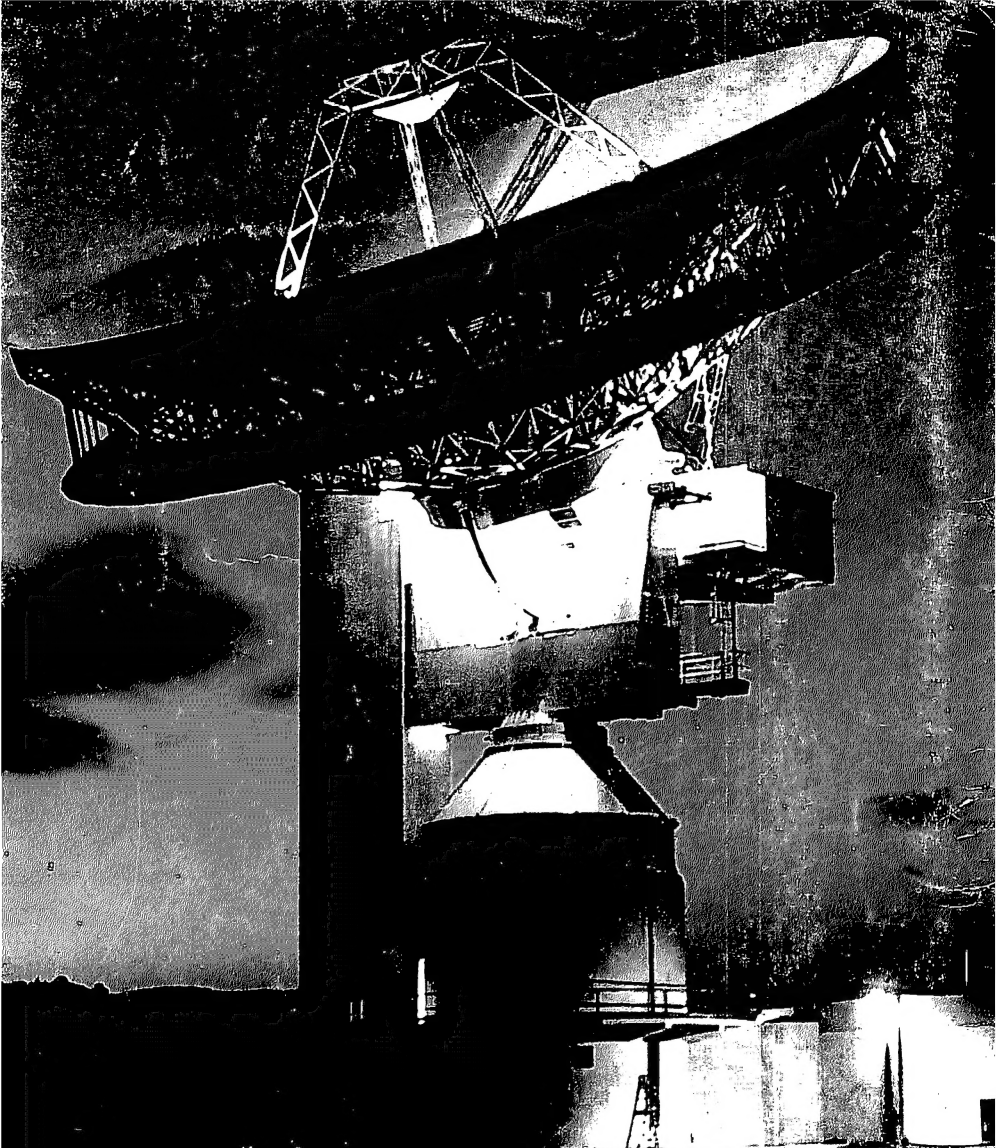
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